Three Essays on Bank Efficiency

A Thesis

Submitted to the Faculty

of

Drexel University

by

Yi-Kai Chen

in partial fulfillment of the

requirements for the degree

of

Doctor of Philosophy

July 2001

DEDICATION

To my parents

ACKNOWLEDGEMENTS

First of all, I would like to thank my parents. Without them, I am not able to write this dissertation now. They encouraged and supported me a lot during the time that I have been in the United States. My brother, Yu-Cheng, was also very supportive while he stayed with me for two years at Drexel University. Without their encouragement and support, I do not think I can finish my degree successfully.

I profoundly thank my advisor, Dr. Higgins, for this unconditional supervision and guidance. Thanks for your strong support not only in academics but also in my daily life. I learned a lot from him. He made a lot of effort in checking my writing. Because of him, my awful writing in this dissertation is still readable. Mrs. Higgins was also very supportive. I appreciated that they regarded me as a student and a friend. I am also very lucky that I know their 14-month old son, Dylan. Without them, I don't think I could have made it.

I truly appreciate the valuable suggestions and guidance from the committee members, Dr. Chiang, Dr. Higgins, Dr. Mason, Dr. Yan, and Dr. Koziara. Dr. Chiang provided me a lot of support and guidance during my time in Ph.D. program. I thank Dr. Mason for leading me into the banking area. I really appreciate his initial ideas so that I can explore such an interesting topic in this dissertation. His updated information was really helpful throughout.

My special appreciation goes to Dr. Yan and Dr. Koziara. They are like my parents in the United States. They took care of my daily life and my academic work. I am so lucky that they treated me like their son. They also made a lot of effort in checking my grammar. It really helped for my job interview. I do appreciate their kindness and generosity.

My gratitude also goes to the faculty of Department of Finance, Dr. Gombola, Dr. Szewczyk, Dr. Goh, Dr. Nelling, Dr. Song, Dr. Liu, and Dr. Doong for their support. Dr. Gombola and Dr. Liu provided me many opportunities and a better environment to study within the finance department. Dr. Szewczyk was also very supportive during my dissertation. Thanks to Dr. Goh, my SAS programming skills were greatly enhanced. Without him I might not have finished processing my huge data sets that quickly. Because of Dr. Nelling, I got a very nice title for my first essay, which helped me in my job searching. Dr. Song is also appreciated for her suggestions and support.

I would like to thank all the Ph.D. classmates and Ph.D. students at Drexel University for their encouragement and friendship. Because of them, I did not feel lonely when I was struggling with my dissertation. I also benefited from their experience. During my time in the doctoral program, there are so many people that I want to mention individually, but I can't because of the space limitations. They have my true appreciation. I also thank the support of Drexel University. Without Drexel and those people mentioned above, I would not have my degree.

I appreciated the tremendous help from Ching-Fen for the final revision. Without her help, I might not be able to complete my dissertation successfully. At the last stage of my dissertation completion, the encouragement and assistant from Amy was also appreciated. I am fully responsible to all mistakes in this dissertation. If I have any success in the future, I dedicate it to all the people mentioned above. Finally, I made it.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Three Essays on Bank Efficiency

Yi-Kai Chen

Eric James Higgins

Since commercial banks play important roles in the financial markets, it is important to evaluate whether banks operate efficiently. Moreover, given increased competition from non-bank financial institutions, commercial banks should operate more efficiently than they did previously. Commercial banks might operate more efficiently if they have superior information. If this is true, bank size should not matter to the operation of the bank. Thus, as long as the bank has superior information, it will operate more efficiently. Therefore, is it necessary that banks should be big to be efficient? Will the numbers of small commercial banks decrease? This dissertation will investigate the survival value of small commercial banks.

There are three essays related to X-efficiencies in U.S. commercial banks in this dissertation. First, the relation between commercial banks' X-efficiency and agricultural factors is examined. Two hypotheses are examined in this essay. First, pairwise comparison tests and regression analyses are used to test relations between X-efficiency and bank size, location, and specialization. Second, the relation between bank X-efficiency and agricultural factors at the county level is examined. Like previous studies, economies of scale are shown to exist in the banking industry. However, the degree of scale efficiency is found to be related to loan specialization.

Larger is not always better for banks with loan specialties in agriculture. Furthermore, agricultural factors, regarded as a proxy for local economic activity, have a significant impact on small agricultural banks. The second essay examines the degree to which commercial bank X-efficiencies are affected through time by monetary policy and macro economic factors. We are able to document that X-efficiency does change through time in a predictable manner. Finally, in the third essay, an improvement in the methodology for calculating bank X-efficiency is examined. The improvement is designed to solve the problems associated with using cross-sectional and time-series panel data. The improved methodology is used to re-examine the empirical results found in the first two essays.

CHAPTER 1

BACKGROUND AND LITERATURE REVIEW

1.1 Background

Because banks still play certain important roles in the financial market, it is important to evaluate whether banks operate efficiently. Recently, the financial market has become more competitive. In order to compete with non-bank, financial institutions, banks should be increasing their levels of efficiency. The size of banks has also become an important issue. Because of the deregulation in the banking industry, there is a trend for banks to merge with others and become larger in size. These trends leave survival questions that must be answered. Is it necessary that banks should be big to achieve scale economies? If economies of scale do exist, is there any survival value of small banks? Do banks with a variety of financial service products operate more efficiency than the banks with specialties? This dissertation attempts to answer these questions by examining the efficiency of agricultural lending, in comparison to the banking industry as a whole. The dissertation also examines the time series pattern of bank efficiency to determine what factors have influenced efficiency changes. Finally, the dissertation proposes a new estimation technique for bank efficiency.

CHAPTER 1

BACKGROUND AND LITERATURE REVIEW

1.1 Background

Because banks still play certain important roles in the financial market, it is important to evaluate whether banks operate efficiently. Recently, the financial market has become more competitive. In order to compete with non-bank, financial institutions, banks should be increasing their levels of efficiency. The size of banks has also become an important issue. Because of the deregulation in the banking industry, there is a trend for banks to merge with others and become larger in size. These trends leave survival questions that must be answered. Is it necessary that banks should be big to achieve scale economies? If economies of scale do exist, is there any survival value of small banks? Do banks with a variety of financial service products operate more efficiency than the banks with specialties? This dissertation attempts to answer these questions by examining the efficiency of agricultural lending, in comparison to the banking industry as a whole. The dissertation also examines the time series pattern of bank efficiency to determine what factors have influenced efficiency changes. Finally, the dissertation proposes a new estimation technique for bank efficiency.

Information asymmetry is the advantage that banks have over other financial institutions. From this perspective, bank size does not matter to the operation of the bank. As long as banks have superior information, they will operate more efficiently. Recently, the increased competition between banks and non-bank financial institutions has increased, especially in the metropolitan statistical areas (MSAs).[1] Larger banks might have advantages of scale economies. However, scale and scope economies may not apply in the non-metropolitan statistical areas (non-MSAs). Given that non-MSAs are generally associated with rural areas, it is likely that agricultural products are the major outputs in this area.[2] Logically, agricultural loans should be one of the important financial services provided by local banks. Thus, agricultural lending should play an important role in the rural market. What kinds of banks should specialize in the agricultural lending? Does bank size matter to the efficiency of agricultural lending in the non-MSA financial market? Are there any local economic factors that might affect the efficiency of the rural bank? One of the major purposes of this dissertation is to examine rural agricultural bank efficiency and determine the factors that influence efficiency at these agricultural banks.

---

[1] The general concept of a metropolitan area (MA) is one of a large population nucleus, together with adjacent communities that have a high degree of economic and social integration with that nucleus. Metropolitan statistical areas (MSAs) are relatively freestanding MAs and are not closely associated with other MAs. These areas are typically surrounded by non-metropolitan counties. The source of the definition is from http://www.calmis.cahwnet.gov/htmlfile/msadef.htm

[2] Jayaratne and Wolken (1999) assume that the MSA is the relevant geographic area for urban banking markets and the non-MSA county for rural markets. Usually, the antitrust regulators also routinely make this assumption.

Another recent trend in the banking industry is consolidation. Figure 1 shows that in the first quarter of 1988 there were 14765 banks, 13537 of which were classified as traditional commercial banks. By the last quarter of 1997, there were 10466 total banks. 9147 of which were commercial banks. Given this degree of decline, can small banks survive? To answer this question, it is necessary to consider solving the problem of information asymmetry between the bank and the investor. Superior information obtained from their customers is one of the advantages that banks have in the financial market. The relationship between banks and customers also is also essential in obtaining reliable information. Maintaining relationships with their customers is an important issue to banks. On the other hand, in order to maintain or extend credit from the bank, bank customers might need to have a relationship with a specific bank. Under this circumstance, relationship lending will be important to ensure bank efficiency. In general, smaller banks might have more flexibility to deal with their customers because they have better relationships with their customers. In other words, larger banks might not be as flexible as smaller banks to satisfy various customers' needs. Hence, smaller banks might do a better job in relationship lending than larger banks. However, moral hazard might occur in the process of relationship lending. Loan officers at small banks might abuse the flexibility they have and adversely affect the cost and quality of the loans. This dissertation examines whether the relationship with local customers of smaller banks will increase or decrease the efficiency of bank operation. Thus, the dissertation will provide more information regarding the survival value of the smaller banks.

Bank efficiency might also be related to macroeconomic movements, such as monetary policy, interest rates changes, and bull and bear market conditions. Logically, such macroeconomic events will influence the economy as a whole. This economic impact may then affect banks and the efficiency of their operations. On a local level, banks will be influenced by regional economic conditions. The small rural banks are likely to be impacted by shocks to agricultural production. Hence, the efficiency of smaller rural banks is likely to be influenced by agricultural conditions in the area. Larger banks that do not specialize in agricultural lending will not be affected by these local economic conditions. Thus, the dissertation examines the impact of macroeconomic factors and agricultural factors on bank efficiency.

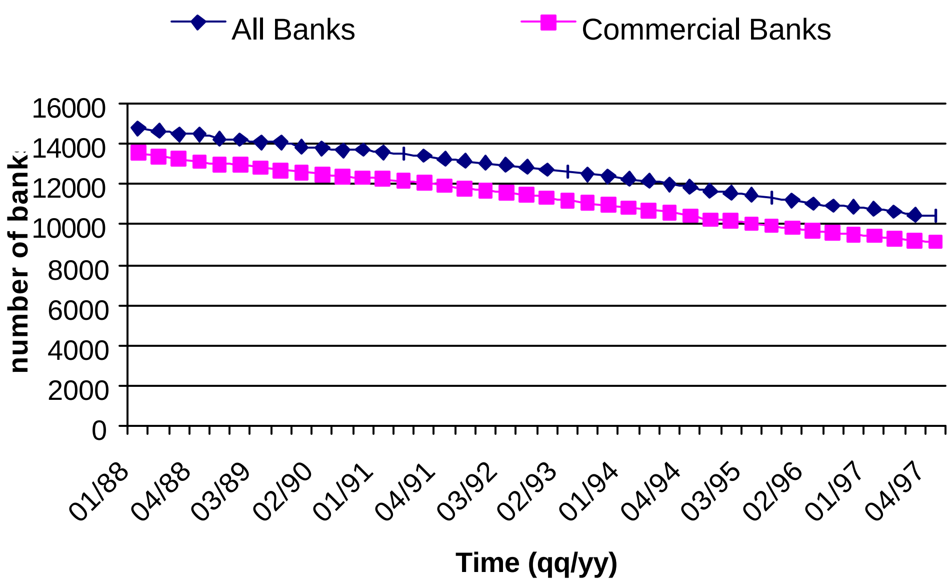

FIGURE 1 THE NUMBER OF ALL BANKS AND COMMERCIAL BANKS IN THE UNITED STATES

1.2 Objectives

First, this dissertation investigates whether small banks in rural markets can survive under the pressure of bank mergers and consolidations. Six categories of banks are examined in the dissertation. The categories are commercial banks in MSAs, commercial banks in non-MSAs, agricultural banks in non-MSAs, agricultural banks in MSAs, non-agricultural banks in non-MSAs, and non-agricultural banks in MSAs.[3] This study hypothesizes that smaller banks might have some advantages, such as superior inside information because of better relationships with customers, flexible and favorable interest rates, and specialization in the specific rural area. If the impact of these factors is positive on bank efficiency, those factors might be an advantage to small bank operation. If those factors have a negative impact on cost efficiency, they might imply that the problem of moral hazard might be a bigger issue in this study. One of the objectives of the study is to differentiate the size of the bank and test whether there is a survival value to the small bank in the rural market. Additionally, this dissertation examines the extent to which banks are influenced by local economic conditions through agricultural outputs. We examine Census of Agriculture data to determine what relationship, if any, agricultural outputs have on bank efficiency. It is hypothesized that banks specializating in agriculture will be greatly impacted by agricultural outputs.

---

[3] Ellinger (1994) defines agricultural banks as banks with more than 25% agricultural loans to total loans.

Therefore, the objective of the first essay is to find the linkage between the cost efficiency of the bank operation and agricultural factors. Traditional X-efficiency methodology and a new estimation approach, developed in the third essay, are both employed to evaluate the efficiency of all commercial banks in the United States. Two hypotheses are tested in this essay. The first hypothesis examines bank efficiency in different categories, based on the bank size, specialties, and charter location. We expect that if there is a benefit to being smaller, it will occur because of a bank's specialization. Thus, we expect that smaller banks that choose to specialize in agricultural lending may be more efficient related to those banks that don't. This could suggest that a bank's survival value is not based on its size but on its degree of specialization. The second hypothesis investigates the relationship between bank efficiency and agricultural factors. Several agricultural factors and change in agricultural prices at both county and state level will be tested in the regression models. Again, we expect agricultural banks to be much more sensitive to agricultural factors. Thus, wile specialization may benefit the bank in terms of efficiency it may also increase the risk level of the bank.

The second essay examines time-series patterns in X-efficiency estimates for banks. The efficiency of the commercial banking industry in the United States might follow the business cycle or the cycle of bull and bear markets. Lead and lag relationships will be tested in this dissertation. However, because of the variety of definitions of business cycles and bull-bear markets, different models will be tested to determine the one that best explains the variance of X-inefficiency in banks. Monetary policy and macroeconomic factors may also play an important role in affecting bank operations. Most literature on bank failures tends to deal with incidents of financial crisis, panic, or contagion. Some attribute these episodes primarily to speculative attacks on the numeraire (Wigmore 1987; Donaldson 1992) or illiquidity shocks (Diamond and Dybvig 1983; Donaldson 1993), whereas others attribute these episodes to increased asymmetric information regarding the incidence of financial distress (Calomiris and Kahn 1991; Bhattacharya and Thakor 1993; Kaufman 1994; Calomiris and Mason 1997). Recent corporate bankruptcy literature further distinguishes between failure arising from systemic events like crisis, panic, or contagion, and unrelated financial pressures (Denis and Denis 1995). Though effective safety and soundness regulations should mitigate the risk of bank failures attributable to individual bank effects like fraud and mismanagement, the industry could still be susceptible to financial weakness arising from a general deterioration in economic conditions. Such an occurrence could presumably lead to conditions of increased bank weakness that would cause a systemic crisis, panic, or contagion. Thus, overall macroeconomic conditions should affect bank efficiency. Jensen, Mercer,and Johnson (1996), Kleim and Stambaugh (1986), Campbell (1987), Fama and French (1988, 1989), Schwert (1990), and Howton and Peterson (1998) all provide evidence that business condition proxies like dividend yields, default spreads, and term spreads explain significant variation in stock and bond spreads. This study hypothesizes that similar indicators reflect the diversification and flexibility of bank loan portfolios. Changes in portfolio condition will ultimately affect bank earnings and expenses, like interest revenue and loan chargeoffs. Thus, business condition factors are also examined in this essay.

Finally, in the third essay, an improvement to the measurement of X-efficiency is examined. X-efficiency is traditionally estimated using the translog function by employing input and output variables to form a cost efficient frontier of all banks. The measurement of X-inefficiency is the distance between costs of banks deviating from the frontier. In general, the input and output variables of the bank are accounting variables that estimate the total costs of the bank. Panel data is used in estimating the X-efficiency of banks. The estimation of the translog function is a second-order Taylor series expansion in output quantities and input prices. Cross-sectional regression analysis is used to estimate the deviation of the bank's cost from the efficiency frontier. However, panel data also has time-series characteristics. The error term of the translog function might not accurately represent the estimation of the distance if there is predictable time-series variation. Thus, the variance of the error term without considering the time series might be higher than that considering both the cross-section and time series. We propose an alternative approach that takes cross sectional and time series panel data into account to improve the estimation accuracy of the error term in the translog function. After the development of the alternative approach, the new approach is applied to the previous two empirical studies and makes comparisons between the original and alternative approaches.

1.3 Literature Review

Bank efficiency has been discussed for years. Recently, because of the rapid growth of financial markets and financial innovations, it has become more important to measure the efficiency of financial institutions. If those financial institutions operate more efficiently, they might expect improved profitability and a greater amount of intermediated funds. Consequently, the consumer might expect better prices and service quality and greater security and soundness of financial systems [Berger, Hunter, and Timme (1993)]. The academic research on the performance of financial institutions has increasingly concentrated on X-efficiency (or Frontier efficiency), that measures deviations in performance from that of best-practice firms on the efficient frontier, holding constant a number of exogenous market factors like the prices faced in local market. The efficient frontier measures how well the financial institution performs relative to the predicted performance of the best firms facing the same market conditions in the industry. X-efficiency often measures cost efficiency of institutions more accurately than does standard financial ratios [DeYoung (1997)]. Comparing the financial ratios of different banks is not appropriate unless the banks are nearly identical in term of product mix, bank size, market conditions, and other characteristics that can affect the costs of the banks. Thus, statistical based “efficient cost frontier” approaches would measure efficiency more accurately. There were 116 out of 130 studies related to financial institution frontier efficiency across 21 countries written or published during 1992-1997 [Berger and Humphrey (1997)].

1.3.1 Liberation of Intra- and Inter- State Branching

There are several factors that might affect the efficiency of the bank. First, geographic deregulation has an impact on the bank operation. The banking industry is highly regulated. Theoretically, those regulations increase banks' operating costs and decrease competition and efficiency within the industry. Kalish and Gilbert (1973) tested whether regulations affect the operating efficiency of banks by using a bank efficiency index.[4] They assumed that bank operational efficiency has a positive relationship with the degrees of current competition and a negative relationship with the degrees of potential competition in the banking industry. The statistical results show no significant effect on the banking industry for current and potential competition. This means that regulations, causing banks to produce services and products at excessive costs, have no significant influence on bank operational efficiency.

In the 1980s, deregulation in financial markets resulted in dramatic changes in the banking industry. Because of deregulation, the barriers to geographic expansion and interest rate ceilings were eliminated. Thus, in the financial market, commercial banks experienced substantial competition from in-state banks, out-of-state banks, and non-bank rivals. Kaufman (1995) suggests the existing regulatory framework is costly and imposes inefficiency.[5] This means that the regulation causes banks to make less profit and be at a greater disadvantage to their non- or less-regulated competitors. Intuitively, the removal of the regulation would increase the efficiency level of the banking industry.

However, Humphrey (1991) finds that deregulation leading to bank mergers might have expensive “one-time” expenditures to integrate back office operations and standardize banking products instead of reducing costs in the short run. Moreover, acquiring banks, rather than removing excess branch office capacity, have tended to perpetuate the overcapacity conditions that might lead to higher costs. Thus, deregulation might result in more costs to the banking industry and make the whole industry less efficient.

In 1994, the Riegle-Neal Interstate Banking and Branching Efficiency Act was passed.[6] Because of this geographic deregulation, there was more and more industry consolidation during 1980s. Certainly, it decreased the share of assets held by small banks. However, Calem (1994) showed that the decreased asset share of small banks was

---

[4] The efficiency index is an estimate of the excessive cost of the bank per unit of output over the average cost the bank would incur if operated at maximum efficiency.
[5] On page 305, Kaufman referred to a study that reported the range of the regulatory cost in the banking industry in 1991 was between $7.5 billion and $17 billion, or between 6% to 17% of the banks’ total non-interest expenses.
[6] The act was passed on September 13, 1994. One year after enactment, a bank holding company (BHC) will be able to acquire banks in any state as long as certain conditions are met. See Calem (1994), page 21.

caused by relaxation of in-state branching restrictions instead of relaxation of interstate restrictions. He argued that the removal of in-state branching restrictions severely influenced small banks because such restrictions excluded many of these banks from achieving an efficient size. After removal of the in-state restrictions, many small banks may seek potential merger partners or acquirers to reach economies of scale. Thus, most banks would be close to an efficient size before the removal of interstate restrictions. Allowing banks to branch interstate would not have a major adverse impact on small bank efficiency. Hughes, Lang, Mester, and Moon (1996) also reviewed the impact of the Interstate Banking Efficiency Act of 1994 on risk diversification by using a structural model of production. Their results suggested that increasing geographic and/or depositor diversification improved expected return. Increases in branches also enhanced efficiency by making inefficient institutions closer to the efficient frontier in both the return and risk dimensions. Evanoff (1998) also supported that allocative inefficiency was a factor before deregulation. However, after deregulation, allocative inefficiency is nearly non-existent. Banks fully exploit scale economies by altering the production process to improve the efficiency of the bank after deregulation.

1.3.2 Interest Rate Ceiling Deregulation

Interest rates play an important role in bank operations. The major business of commercial banks is taking deposits and making loans. When the interest rate increases, the cost of a bank's liabilities also increases. However, the interest rate of the bank's loans will also increase. In the past, interest rate ceilings kept deposit costs low creating less volatility in the spread between a bank's deposits and liabilities. Interest rate deregulation caused higher bank funding costs and lower bank profits in the early 1980s, because the cost of raising funds for commercial banks was closely related to interest rates in the money and capital market.[7] This increased the volatility of raising funds for banks. Lam and Chen (1985) expected that banks of different sizes (small and big banks) might react differently to changes in capital regulation because of the phase out of the interest rate ceiling. Brown (1983) found the deregulation of interest rates gave more freedom to the small community bank. However, community-oriented small banks might also be at risk to interest deregulation because of the their traditionally high concentration of low-cost deposits. Brown shows that high-performance banks maintain the profitability by controlling non-interest expenses to compensate for decreased margins

---

[7] The 1980 Depository Institution Deregulation and Monetary Control Act (DIDMCA) phased out interest rate ceilings (Regulation Q) by 1986.

and when comparing the non-interest expenses, Brown shows that smaller banks are more efficient than the larger banks.[8]

Humphrey and Pulley (1997) showed that large banks bore the brunt of interest rate deregulation between 1977-1981 and 1981-1984.[9] Large banks tend minimize the negative impact on profits from the deregulation-induced rise in funding costs by adjusting their use of labor and capital inputs and deposit and loan output prices. However, between 1981-1984 and 1985-1988, the situation was reversed for the large banks. According to the evidence of Humphrey and Pulley, smaller banks with assets between $100 and $500 million had done less adjustment to the deregulation. Thus, those smaller banks less relied on the improved business environment in order to stabilize profitability and larger banks relied more on the business environment to improve their profitability. The results also imply that the volatility of larger banks' profits is higher than that of smaller banks after the deregulation of the interest rate ceiling.

---

[8] Brown (1993) suggests that productivity, low employment turnover, and reductions in staff are the major measures used to control costs.
[9] Large banks are those with assets over $500 million.

1.3.3 Legislation in the Agricultural Banking Industry

In this dissertation, agricultural banks are examined. The quality of agricultural loans will affect the cost of bank operations. Thus, agricultural loans have a direct impact on operational efficiency for agricultural banks. Therefore, regulation in the agricultural loan sector will play role in the efficiency of agricultural banks. The history of federal legislation on farm credit shows a federal mandate to channel credit to the farm sector. The Federal Land Bank system was formed in 1917. In 1930s, the system was expanded to the Farm Credit System under the aegis of the New Deal. The agency was re-capitalized to Federal Agricultural Mortgage Corporation (Farmer Mac), which allows financial institutions to sell certain agricultural and rural housing loans in a secondary market [Gilbert and Kliesen (1995)]. Gilbert and Kliesen indicated that agricultural banks as a group were more profitable than other banks from 1970 through 1983.[10] However, due to the low capital ratio of agricultural banks, many agricultural banks failed during the period from 1984 to 1987.

Belongia and Gilbert (1990) indicated that two major adverse shocks in 1920s and 1980s caused problems in the performance of agricultural banks because of the undiversified loan portfolios held by the agricultural banks. Gilbert and Kliesen (1995)

---

10 The Competitive Equity Banking Act of 1987 (CEBA) created a special program for banks with total assets less than $100 million and agricultural loans more than 25% of their total loans. Qualifying banks

also suggested that regulators could require banks with higher ratios of agricultural loans to total assets to maintain their higher capital ratios.[11] Their results proved that there are no significant rewards to society from relaxing the safety and soundness regulations that apply to banks that specialize in agricultural lending.

1.3.4 Relationship Banking

The relationship between the customers of agricultural loans and banks is a major issue that this dissertation focuses on. Relationship lending should play a key role in small business and agricultural loans. Although the entry of mutual funds and non-bank financial institutions increases the competition for banks, they still play a major role in this market because they decrease the level of asymmetry information by producing and analyzing information. Berger and Udell (1995) found that the relationship between banks and their small-firm borrowers are valuable. Small-firm borrowers with longer banking relationships pay lower interest rates and are less likely to pledge collateral.

---

were allowed to write off their loan losses over several years. However, CEBA does not reflect special regulation for agricultural banks.

Petersen and Rajan (1994) suggested that the availability of finance from banks increases as the small firm spends more time in a relationship, as it increases ties to a bank by expanding the number of financial services it buys from the bank, and as it concentrates its borrowing with the bank. Thus, Petersen and Rajan (1994) suggest that a firm with close ties to a specific financial institutions should have lower cost of capital and greater availability of funds than that without such ties if scale economies exist in information production and information is durable and not transferred easily.

However, young firms who get loans from banks are more indebted in concentrated markets than in competitive markets. Yet, the pattern reverses for older firms. It seems that banks try to smooth interest rates over the life cycle of the firm in a concentrated market. In other words, banks charge lower than competitive rates when the firm is young and higher than competitive rate when the firm becomes old. Cole (1998) shows that pre-existing relationships between the firm and the bank, like pre-existing saving accounts and financial management services at the lender, are important. These relationships are important factors in determining the likelihood of the extension of credit to the firm. It means that such relationships generate valuable private information about

---

[11] Gilbert and Kliesen (1995) indicated that banks with higher proportions of agricultural loans to total assets did not tend to have higher capital ratios in 1993. Thus, higher capital ratio requirements can reduce the credit risk of agricultural banks.

the firm's financial situation.[12] Elsas and Krahnen (1998) also find information-intensive lender-borrower relations in Germany. Boot and Thakor (2000) suggest that there is more transaction lending at lower levels of interbank competition than higher levels.[13] Competition in the banking industry will increase relationship lending. However, each loan will have less value added for the borrower. Relationship loans will have higher added value for borrowers if capital market competition is higher.

Ferri and Messori (2000) examine relationship banking in three macro-areas in Italy. They show that relationship banking is characterized by both the fast-growing area and the marginal area of dependent development. They conclude that relationship-banking patterns would become efficient only if they encourage efficient banks to promote autonomous local development to supply credit flows and more sophisticated financial services.

---

[12] Cole (1998) demonstrates that the length of the relationship is unimportant. However, the bank is less likely to extend credit to firms with multiple sources of financial services.

[13] Berlin and Mester (1998) suggest that credit scoring models and securitization remake the small business lending market in the image of the consumer loan market. Transaction lending is usually the way that larger banks make small-business loans. Relationship lending is characterized by close monitoring, re-negotiability, and implicit long-term contractual agreements. Commercial banks, especially small banks, dominate in the small-business loan market by using traditional relationship lending.

1.3.5 Bank's Roles in the Rural Financial Market

Urban and rural markets can be regarded as two major markets of commercial banks. In the urban areas or metropolitan statistical areas (MSAs), larger banks might reach economic scale and take advantage of their branching opportunities. Thus, because of the competition, larger banks might perform better and become more efficient than smaller banks in these areas. However, in the rural market, the competition level of banks might vary. Since the Riegle-Neal Interstate Banking and Branching Efficiency Act, larger banks could enter the rural market that they previously may have ignored. Weber and Devaney (1998) investigated the relationship between the bank efficiency and community lending in the Lower Mississippi Delta Region (LMDR).[14] They found that rural banks were less technically efficient because they might be constrained from loaning outside of their local market, compared with the multi-state bank holding companies that can underwrite loans to broader geographic regions. Thus, a lack of credit worthy borrowers might lead to less efficiency in rural banks. Gilbert (1997) and Gilbert (2000) asserted, however, that the entry of larger banks in the rural market after the deregulation of the interstate branching would enhance competition in rural financial markets.

---

[14] The LMDR in Weber and Devaney (1998) study, included Arkansas (38 counties), Illinois (11 counties), Kentucky (11 counties), Louisiana (30 counties), Mississippi (38 counties), Missouri (29 counties), and Tennessee (19 counties). 176 out of 219 counties are rural counties.

The evidence of Gilbert and Belongia (1988) shows that the percentage of lending to farmers has had an inverse relationship to the size of their parent organization among those banks in rural areas. This means that the gap in agricultural loan ratio is positively related to the asset size of the bank holding companies. Gilbert and Belongia suggest that their results show that larger banks might be able to diversify their loans in other markets. Thus, banking consolidation may restrict the access of farmers to credit from banks. In other words, rural banks that are not subsidiaries of large banks or bank holding companies have less opportunity to diversify risk in their loan portfolios. Thus, smaller rural banks without any affiliation with large banks or bank holding companies might invest a relatively higher percentage of their assets in agricultural loans because they have a limited choice for lending opportunities. This implies that when rural banks became larger and were acquired by the out-of-state larger banks or bank holding companies, local borrowers, especial farmers, might have less available credit from the banks. However, Featherstone (1996) finds the opposite to be true. On average, he observed that rural banks did not tend to reduce the percentage of agricultural loans to the total loans three-year after a bank consolidation. He found a positive relationship between the agricultural loan ratios of the acquired banks and the acquiring banks. He found that relatively larger banks specializing in agricultural loans acquired smaller banks also specializing in the same industry. Keeton (1996) also finds similar results.

He did not find a significant reduction of rural business and agricultural lending during the first three years after a bank merger.[15] Yet, out-of-state acquisition of rural banks owned by urban organizations reduced business lending by 34 percent over three years. Jayartne and Strahan (1996) found that the growth of income at the state level is influenced by the relaxation of branching restriction. They show that liberalizing branching restriction stimulated state economic growth. Yet, the results only indicated gains at the state level not the county level. Thus, whether deregulation in the rural financial markets would stimulate local economic growth is still an ambiguous picture.

Gilbert (1997) suggests that large banking organizations would dominate in most rural counties. However, he mentioned that the recent changes in bank regulation were favorable to reduce the regulatory burden of relatively small banks. Because of the regulatory relief to the smaller bank, those smaller banks would become an important source of credit for rural business and residents that were not served by the large banking organizations. In order to survive in the rural market dominated by larger banking organizations, smaller banks in the rural market would provide more service and operate more efficiently in their communities. The results from Neff and Ellinger (1996) are also interesting. They examined the participants in rural bank consolidations. They showed that rural banks with considerable agricultural lending had not been the primary targets of

---

[15] Keeton (1996) used commercial and industrial loans as the measure of business loans, and the sum of farm operating and farm real estate loans was used as the measure of farm loans.

acquisitions involving interstate combinations. This implies that consolidation in rural banking industry would not significantly affect the accessible farm loan credit. Thus, if the rural agricultural banks are profitable, they should survive and perhaps be more efficient than their non-agricultural competitors.[16]

We assume that the accessibility and availability of agricultural loans has positive relationship to the expansion of agricultural production. Thus, does lack of access to agricultural loans constrain agricultural production? Kochar (1997) examined whether the access to formal credit affected the agricultural production in rural India. The results show that the relationship between the availability of agricultural loans and agricultural production is positively significant in the rural India. Drabenstott (1999) also indicated that rural businesses were forced to rely more on loans rather than equity capital to finance their operations. This situation might also be applied in the agricultural industry. Local farmers may have limited sources to raise the funds. Agricultural loans may be their major source of funds. On the other word, agricultural loans may also be the major business of banks in the rural market. Thus, bank efficiencies are correlated to one of their outputs, loans. The availability of agricultural loans may affect agricultural

---

[16] Belongia and Gilbert (1990) indicated that agricultural banking is profitable in general. They found that agricultural banks performed efficiently in agricultural lending, except during agricultural shocks. Agricultural shocks might cause some problems for those agricultural banks that were not well diversified in their loan portfolios

production. Thus, a relationship between agricultural production and bank efficiencies may exist.

1.3.6 Business Cycles, Monetary Policy, Agricultural Outputs, and Macroeconomic Effects on Bank Efficiency

The banking industry is very sensitive to macroeconomic conditions. Thus, the operation of the bank should be closely related to economic movements. Therefore, business cycles and monetary policy might affect the efficiency of a bank. Loans are one of the bank's major outputs. There is a linkage between loan and business cycles and monetary policy movements. Problem loans might occur more frequently in worse economic conditions. Berger and DeYoung (1997) interpreted several reasons that cost inefficient banks might tend to have problem loans. One potential reason that they cite is local economic downturns.

Since loans are one of the bank major outputs, problems loans might lead to bank X-efficiency reduction. Berger and DeYoung (1997) employed Granger causality techniques to test the relation between loan quality and a bank's cost efficiency. They found intertemporal relationships between loan quality and cost efficiency in both directions. They indicated that high levels of problem loans caused banks to increase costs in monitoring, working out, and/or selling off those problem loans. Thus, those non-performing loans tended to decrease the cost efficiency of banks. DeYoung (1998) also found similar results. He found that cost efficiency is positively related to examiners' ratings of the management quality. His results also showed that banks' management ratings were strongly related to their asset quality rating. Berger, Bonime, Covitz, and Hancock (2000) also indicated that bank performance was sensitive to regional/macroeconomic shocks. They show that even the greater geographic diversification and the greater use of financial engineering techniques employed to manage risk in recent years still could not reduce the banking industry's sensitivity to regional/macroeconomic shocks. They also explained that bank profitability would increase during economic boom periods because all regions likely had the unexpected favorable economic conditions. During favorable macroeconomic conditions a shifting toward higher-return investments with higher-risk taking might occur (Berger and Mester (1999), Berger, Bonime, Covitz, and Hancock (2000)). Thus, if this was the case, the profitability of banks should increase. However, this does not mean that banks can reduce the cost efficiently. The cost efficiency in the banking industry may reduce during the boom economy. However, during downturns in the economy, the banking industry might need to operate more efficiently in order to survive. Thus, the effect of economic conditions on efficiency is still a question mark.

On the other hand, bank lending might also affect the local or macro economy. Schumpeter (1911) asserted that the financial system could promote economic growth. He argued that the services provided by financial intermediaries, such as mobilizing savings, evaluating projects, managing risk, were necessary for economic development and technological innovation. King and Levine (1993) find the results that were consistent with the Schumpeter's view by using cross-country data of 80 countries over the 1960-1989 periods.

1.4 Organization

In Chapter 2, the estimation of X-efficiencies is discussed. Several different estimation techniques will be reviewed. Chapter 3 contains the first essay of the dissertation. In this essay, bank efficiency comparisons based on the bank's size, charter location, and loan specialties are examined. The relationship between bank efficiency and agricultural factors at the county level is also examined. In chapter 4, essay 2 investigates the time series pattern of bank efficiency. The essay examines whether efficiency is associated with business cycles, monetary policy, and economic growth. In Charter 5, essay 3 develops an alternative approach to estimate X-efficiency employing both cross sectional and time series panel data. The alternative approach is also applied to the empirical studies in essays 1 and 2. Finally, chapter 6 will present the results of this study and discuss the contributions of this study.

CHAPTER 2

MEASUREMENTS ON BANK EFFICIENCY

The overall bank efficiency can be decomposed into scale efficiency, scope efficiency, pure technical efficiency, and allocative efficiency. The bank has scale efficiency when it operates in the range of constant returns to scale. Scope efficiency occurs when the bank operates in different diversified locations. When the bank maximizes the output from the given level of input, pure technical efficiency occur. Technical efficiency is the major method that this study employs to measure bank efficiency. Allocative efficiency happens when the bank chooses the revenue maximizing mix of outputs. Theoretically, a bank is fully efficient if it produces the output level and mix that maximize profits and minimize possible costs. However, in reality, most banks are not fully efficient. There are a number of sources of inefficiency in the banking industry.

A professional note from Berger asserts that the most important origin of cost problems in the banking industry is X-efficiency or differences in managerial ability to control costs for any given scale or scope of production.[17] They also mentioned that on average, banks' costs were about 20% above the efficient frontier. This means that a bank, on average, has costs around more than 20 % more than a "best-practice" bank producing the same products. Most of the sources of the inefficiencies are caused by inappropriate operation, like excessive use of labor in branch offices, and financial inefficiency, such as excessive interest paid for funds.

2.1 Scale Efficiency

In banking, the average cost curve has a relatively flat U-shape, with medium-sized firms being slightly more scale efficient than either very large or very small banks.[18] The primary uncertainty expressed in Humphrey (1990) is the location of the bottom of the average cost U – the scale efficient point. McAllister and McManus (1993) suggested that the commonly used translog cost function specification gives a poor approximation when applied to banks of all sizes. The translog does not hold up as a reasonable global approximation because it forces large and small banks to lie on a

[17] The professional note is shown on Saunders' (1997) book.
[18] See the survey by Humphrey (1990).

symmetric U-shaped ray average cost curve and disallows other possibilities, such as an average cost curve that falls up to some output point and remains constant thereafter. Thus, it may be the case that the diseconomies found for larger banks are simply the imposed reflection of the economies found for the small banks. In addition, the translog approximation may behave poorly away from the mean product mix, which can create problems in measuring scale efficiencies because large banks tend to have very different product mixes from the average.

McAllister and McManus's (1993) solution to this problem is to replace the translog with one of several nonparametric estimation procedures. Their other innovation is to add a missing factor to the calculus of scale efficiency – risk. They show that as bank loan portfolios increase in size up to about $1 billion, the standard deviation of the rate of return falls precipitously, presumably because of diversification benefits. The reduction in risk lowers the amount of financial capital that must be held by the bank to keep the risk exposure of the bank's creditors (including the deposit insurer) at a given level. Because capital is the most expensive marginal source of funding, this creates a financial scale economy by which banks can lower their average costs of funds as scale increases by holding a smaller proportion of capital. This represents an improvement over two previous attempts to incorporate risk into the cost function for financial institutions, one of which specified risk but did not include its cost, and one which measured risk by provisions for loan loss reserves, which reflect expected losses rather than the risk or variance of losses.[19] McAllister and McManus find substantial scale inefficiency for small banks, full-scale efficiency reached by about $500 million in assets, and approximately constant average costs thereafter up to $10 billion in assets, the upper limit of their sample. Another potential difficulty in the scale economy literature is that most studies do not use a frontier estimation method. Scale economies theoretically apply only to the efficient frontier, and the use of data from banks off the frontier could confound scale efficiencies with differences in X-efficiency. Fortunately, Berger and Humphrey (1991), Berger et al. (1992), McAllister and McManus (1993), and Mester (1993) have compared scale efficiencies on and off the efficient frontier and have found only small differences.

2.2 Scope Efficiency

Prior studies on scope efficiency for financial institutions are even more problematic than the scale studies. The degree of scope economies measures the percentage change in production costs if specialized firms, as opposed to a single firm

---

[19] See Hughes and Mester (1992)

produced a bank's products. If the measure is positive, scope economies exist and the bank producing multiple products is more efficient than several specialized banks. If the measure is negative, there are scope diseconomies and specialized banks operate more efficiently.

Three major problems have been recognized. First, there is a problem in applying the translog specification to evaluate or test for scope economies. The second recognized problem in estimating scope economies is that there is often little or no data on firms that specialize. In banking, virtually all firms produce the entire array of products specified in the cost function. In fact, the dense part of the data set is usually away from zero outputs, creating potentially significant problems of extrapolation. The effects of extrapolation, often combined with the problems of the translog specification, can be quite dramatic – measured scope economies and diseconomies are often erratic and far exceed credible levels, at times over 1,000 percent in absolute value.[20] The third recognized problem in evaluating scope economies is that of using data that are not on the efficient frontier. As in the case of scale economies, scope economies are defined only on the efficient frontier, so that evaluation, using data off the frontier, could confound scope economies with X-efficiencies. The empirical evidence shows there does not seem to be much in the way of scope economies or diseconomies. The studies suggest that the cost efficiency of banks offering a variety of financial services and those of offering just a few services should be identical. A professional note from Mester in Saunders (1997) addressed that although the empirical work seemed to imply that consolidation could improve the efficiency, cost savings from mergers of large banks should not be expected. She suggested that there appeared to be room in the industry for both large and small, and supermarket and boutique banks. Berger and Humphrey (1991) found scope diseconomies of about 10-20% on the frontier and economies in the 1,000s of percent when the entire data set was used. Mester (1993) also finds huge differences between scope economies on and off the frontier.

2.3 X-Efficiency

X-efficiency is defined as the ratio of the minimum costs that could have been expended to produce a given output bundle to the actual costs expended.[21] X-efficiency varies between 0 and 100 percent. X-efficiency includes both technical inefficiency, or errors that result in general overuses of inputs, and allocative inefficiency, or errors in choosing an input mix that is consistent with relative prices. Berger and Humphrey

---

[20] See Berger and Humphrey (1991), Pully and Humphrey (1993), and Mester (1993).
[21] The assumptions are from Berger (1993) and Berger, Hunter, and Timme (1993).

(1997) show that 116 out of 130 studies related to financial institution frontier efficiency across 21 countries were written or published during 1992-1997.

There are four types of X-efficiency estimation based on different assumptions. They are the Data Envelopment Analysis (DEA), the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA), and the Distribution-Free Approach (DFA). They differ from one another on the basis of the arbitrary assumptions used to disentangle efficiency differences from random error using a single observation for each firm. We separate those approaches into categories based on the parametric and non-parametric approaches.

- Nonparametric linear programming approach – Data Envelopment Analysis

- Parametric Econometric Approaches – Stochastic Frontier Approach, Thick Frontier Approach, and Distribution-Free Approach

2.3.1 Stochastic Frontier Approach

The SFA assumes that inefficiency follows an asymmetric half-normal distribution, while random fluctuations follow a symmetric normal distribution. The efficiency results depend critically on the skewness of the data – any inefficiency components that are more or less symmetrically distributed will tend to be measured as random error and any random error components that are more or less asymmetrically distributed will tend to be measured as inefficiency. The SFA results also depend on the arbitrary assumption that the X-efficiencies are orthogonal to the cost function exogenous variables, including those used to compute scale efficiency. According to the conventional scale economies literature, if X-efficient firms tend to compete well and become large, the SFA may falsely attribute X-efficiency to scale efficiency. The major reason for this is that the coefficients on the output regressors pick up the correlation with the X-efficiency factors, which are in the composite error term. The SFA cost function coefficients may be biased, leading to misestimates of X and scale efficiencies, if some of the input prices are correlated with X-efficiency. For example, this may occur if banks facing relatively high wages tend to innovate and become more X-efficient.

2.3.2 Thick Frontier Approach

The TFA assumes that deviations from predicted costs within the lowest average-cost quartile of banks represent random error, while deviations in predicted costs between the highest and lowest quartiles represent inefficiency. The TFA estimates separate cost functions for the lowest and highest average-cost quartiles. The residuals for both functions are assumed to represent only random error, while the predicted difference between the two functions is assumed to represent X-efficiency differences. The measured efficiency under the TFA is obviously sensitive to the assumptions about which fluctuations are random and which represent efficiency differences. For example, the TFA may mistake one for the other if random errors follow a thick-tailed distribution and tend to be large in absolute value while inefficiencies follow a thin-tailed distribution and tend to be small.

2.3.3 Data Envelopment Analysis Approach

The DEA assumes that there are no random fluctuations, so that all deviations from the estimated frontier represent inefficiency. If there is any luck or measurement error in an observation not on the estimated frontier, it will be mistakenly included in that firm's measured efficiency. If there is a random error in an observation on the frontier, it will be mistakenly reflected in the measured efficiency of all firms that are measured relative to that part of the frontier. Because DEA uses only the data on inputs and outputs and does not take direct account of input prices, it does not incorporate allocative inefficiency.[22]

---

[22] EFA, TFA, and DFA take account of all cost deviations from the minimum, including those owing to errors in responding to input prices.

2.3.4 Distribution-Free Approach

In the stochastic frontier approaches, making explicit distributional assumptions disentangles the inefficiency and random error components of the composite error term. The random error term is assumed to be two sided, which usually is normally distributed, and the inefficiency term is assumed to be one-sided, which is usually half-normally distributed. Both parameters of the distributions are estimated and can be used to obtain estimates of bank-specific inefficiency. Bauer and Hancock (1993) and Berger (1993) found that when the inefficiencies were unrestricted, the efficiencies were much more like systematic normal distributions than half-normals, indicating the identification of the inefficiencies. If panel data are available, some of the maintained distributional assumptions in the stochastic frontier approach can be relaxed, and the distribution-free approach (DFA) may be used. The DFA assumes the efficiency differences are stable over time while random error average out over time. A cost or profit function is estimated for each period of a panel data set. The residual in each separate regression is composed of the inefficiency and random error. Since the random error component is assumed to average out over time, the average of a bank's residuals from all of the regressions is an estimate of the inefficiency of the bank.

2.4 Estimation of X-Efficiency

X-efficiency is the primary approach that we employ to measure the efficiency of U.S. banks. We use the translog flexible function form to estimate the cost structure of banks and derive a measure of bank efficiency.[23] The translog function has been used widely to analyze the cost characteristics of depository institutions.[24] The standard tranlog function is given by the following:

$$\ln TC_{ti} = \alpha_0 + \sum_{k=1}^{6} \beta_k \ln(y_{kti}) + \sum_{l-1}^{4} \alpha_l \ln(p_{lti}) + 0.5 \sum_{k=1}^{6}\sum_{j=1}^{6} \beta_{kj} \ln(y_{kti}) \ln(y_{jti})$$

$$+ 0.5 \sum_{l=1}^{4}\sum_{h=1}^{4} \alpha_{lh} \ln(p_{lti}) \ln(p_{hti}) + \sum_{k=1}^{6}\sum_{l=1}^{4} \delta_{lk} \ln(y_{kti}) \ln(p_{lti}) + \ln(x_{ti}) + u_{ti}, \qquad (1)$$

where x_{ti} represents the X-efficiency factor and u_{ti} is the random error. The current specification assumes six standard bank outputs and four input prices. The inputs and outputs are the following:

TC_{ti} = total costs of bank i at time t

---

[23] The translog function is also used as the cost equation in Mester (1987) and English et al. (1993)

y_k = bank outputs (1: real estate loans, 2: agricultural loans, 3: commercial and industrial loans, 4: personal loans, 5: deposit liability for transaction accounts, and 6: deposit liability for non-transaction accounts).

p_l = price inputs (1: total interest expenses 2: price of capital, 3: labor, and 4: federal funds rate).

Cost-share equations are derived from Shephard's Lemma as follow:

$$\frac{\partial \ln TC_{ti}}{\partial \ln(p_{lti})} = S_{lti} = a_l + \sum_{h=1}^{4} a_{lh} \ln(p_{hti}) + \sum_{k=1}^{6} d_{lk} \ln(y_{kti}), \qquad (2)$$

A share equation is omitted in order to prevent singularity. We estimate the equation formed by equation (1) and (2) subject to homogeneity and symmetry restrictions by the method of seemingly unrelated regressions (SUR).

If a firm systematically incurs relatively higher costs than the other firms in a competitive environment, it is considered X-inefficient. In this study, we assume the

---

[24] See the survey of Berger, Hunter, and Timme (1993) for a discussion of the translog cost function.

efficiency differences are stable over time, while random error averages out over time. Thus, we employ the distribution-free approach proposed by Berger (1993) to estimate the efficiency of the banks.[25] From equation (1), we can define $e_{ti} = \ln(x_{ti}) + u_{ti}$. Peristiani (1997) indicates that residual can be transformed so that the minimum is zero. Thus, we can get equation (3):

$$\hat{\boldsymbol{e}}_{ti} = \min\{\hat{e}_{ti}\} - \hat{e}_{ti}, \tag{3}$$

By taking the exponential of equation (3), we can obtain the X-efficiency as

$$XEFF_{ti} = \exp(\hat{\boldsymbol{e}}_{ti}), \tag{4}$$

Thus, $XEFF_{ti}$ is normalized to fall between zero and one. However, $XEFF_{ti}$ is not robust to outliers. Berger modifies the observations that fall below the p-th percentile so that they are set to the p-th percentile value ($\hat{\boldsymbol{e}}_{ti}^{(p)}$), and observations that exceed the (1-p)-th percentile are valued at ($\hat{\boldsymbol{e}}_{ti}^{(1-p)}$). Thus, the modified X-efficiency can be defined as:

---

25 See also the discussion in DeYoung (1997) for a diagnostic test for the distribution-free X-efficiency estimator.

$$XEFF_{ti}(p) = \exp[\hat{e}_{ti}^{\;(p)} - \max\{\hat{e}_t^{(p)}, \min\{\hat{e}_{ti}, \hat{e}_t^{(1-p)}\}]. \tag{5}$$

CHAPTER 3

ECONOMIES OF SCALE IN THE BANKING INDUSTRY: THE EFFECTS OF LOAN SPECIALIZATION

3.1 Abstract

Popular belief holds that banking consolidation will result in a small number of large monopoly banks that can achieve substantial economies of scale and outperform small competitors. But research suggests that small banks are sometimes more efficient than their large counterparts. One competitive strategy undertaken by numerous small banks is agricultural lending. Agricultural lending is thought to benefit from micro-level monitoring to gauge whether borrowers implement scientific farming practices and exert requisite care to maximize yield and repay bank loans. This essay uses county-level data from 1992 Census of Agriculture to classify agricultural banks and evaluate their lending activities in terms of cost efficiency. Agricultural production, product-mix, crop yields and product prices are key factors affecting the performance of agricultural lending. They are used to explain disparities in bank efficiency. Agricultural lending is found to be positively correlated to bank efficiency. The results also show that it is not necessary to be large to be efficient for the banks with loan specialization. Nevertheless, both rural and urban banks tend to be susceptible to price volatility in the agricultural sector.

3.2 Introduction

Before interstate banking deregulation, there were numerous small unit banks in the United States. After deregulation, the number of banks decreased dramatically (See Figure 2). From 1988 to 1997, the total number of banks decreased 29%, while the number of commercial banks decreased 32.6% (Figure 2 and Table 1). Acceleration of mergers and acquisitions seems to be the main culprit for the decline. In terms of size, large and medium size banks actually grew in number, while the number of small-sized banks declined by 46%. Nevertheless, there are still 5818 small banks left, much more than the number of large and medium banks. Looking at the data in Table 5, it appears that large banks are concentrated in metropolitan statistical areas (MSAs), accounting for 9.71% of the number of banks, while small banks congregate in rural areas, accounting for 42.89% of the number of banks. Do rural small banks have an inherent advantage associated with their specialty and location over large metropolitan banks?

As financial intermediaries, banks mitigate the problem of information asymmetry between lenders and borrowers. Timely and reliable customer information is essential for successful banks. Good information in turn requires close relations with customers. It is alleged that small local banks dealing with small customers are in a better position to develop and maintain close customer contacts than large banks. Small customers, without established credit, also tend to be more loyal to small banks than big banks. If small banks indeed have a comparative advantage in relationship banking to large banks, this may be key to their continued existence. Relationship banking, however, may sometimes lead to moral hazards. Large banks tend to adhere rigidly to rules and criteria in loan review while loan officers in small banks may have some discretion that they may misuse and thereby compromise loan quality.

This study tries to find whether small banks have a comparative advantage in relationship banking by comparing their efficiency with that of larger banks. In agriculture, great uncertainty and gyrations in yields and prices require a more in-depth understanding of customer situations, local environments, government policy, and fluctuations in agricultural exports in order for sound lending to occur. Examining the efficiency of agricultural banks could shed light on the future viability of small banks in coping with increasing competition from consolidated super banks. Also, examining agricultural banks gives us some insight on the effect of specialization on a bank's efficiency and, hence, its ability to survive.

In contrast to earlier studies, the efficiency of small, rural, agricultural banks is studied by simultaneously examining the effect of size, location and lending specialty. In addition, the effect of the local agricultural environment on bank efficiency is studied in detail to see if the degree of specialization required in rural agricultural areas affects banking efficiency.

Figure 3 and Figure 4 show the number of specialty banks and managed assets of specialty banks in the United States in 1996. Most commercial banks are classified as general commercial banks. There are no specific target customers for those banks. However, there are still significant numbers of banks with loan specialties in the banking industry. Figure 3 shows that 14.31% of U.S. commercial banks are classified as agricultural banks. Although the number of mortgage banks, with residential, non-residential, and redevelopment loans specialties, is the second largest in terms of the number of banks in the commercial banking industry in 1996, the information asymmetry in the mortgage market is low. Banks with specialties in agricultural lending are specialty banks with high information asymmetry. Although Figure 4 shows agricultural lending is only 1.08% of all lending in the specialties banks, the number of agricultural banks is still high in the banking industry. Therefore, agricultural banks, which have high information asymmetry, are the target banks examined in this study.

Because of the high information asymmetry in agricultural banks, relationship banking might be one of the important issues of bank operating efficiency. Generally, economies of scale do exist in the banking industry. However, in banks with loan specialization, this might not be the case. In term of operating cost efficiency, specialty banks with superior inside information might not need to be large in order to be cost efficient. Thus, one of the objectives of this study is to examine whether economies of scale exist in the banking industry with loan specialization. Due to the high information asymmetry in the agricultural lending sector and the relatively high percentage of the agricultural banks in the U.S. banking industry (Figure 3), agricultural banks are examined in this study. Whether the smaller banks with agricultural loan specialization have survival value under the trend of bank consolidation is an important issue that we examine in this study.

Banks specializing in agricultural lending might be influenced by local agricultural production. Thus, the fluctuation of agricultural production and price might impact bank operating efficiency. In order to capture the impact of local economic activities on bank efficiency, agricultural factors at the county level are used to proxy for local economic conditions and are examined to determine whether there is a scale of economy effect in banks with loan specializations in agriculture.

3.3 Literature Review

Bank performance is found to vary with size, time, location, loan portfolio-mix and location. Small banks appear best at lending to small local business. Small banks are better at relationship banking than large banks due to superior information and greater discretion in applying information. Nakamura (1994) and Udell (1989) concluded that loan officers at large banks tend to follow bank rules and criteria more rigidly in loan review than their counterparts at small banks.[26] Furthermore, Brickley, Linck, and Smith (2000) found that small local owned banks have a comparative advantage over branch

[26] Nakamura (1994) indicates that small businesses are defined as businesses that have less than $10 million in annual receipts and borrow less than $3 million from all sources.

banks of large banks in some environments.[27] Thus, banks with smaller sizes might survive under the trend of bank consolidation.

Neely and Wheelock (1997) and Zimmerman (1996) showed that time plays an important role in bank efficiency. As the business environment varies from region to region, Neely and Wheelock and Zimmerman indicate that local economic factors affect the performance of local banks significantly. Bank location is a strong factor in determining loan portfolio-mix. For example, farm loans are likely to be made by rural banks due to their proximity to farmers. Levonian (1996) showed that banks headquartered in metropolitan areas, even through they have branches in agricultural areas, are less likely to engage in agricultural lending. The study of the effect on bank efficiency of structural and environmental factors by Neff, Dixon, and Zhu (1994) found that a higher agricultural loan ratio reduces cost inefficiency but increases profit inefficiency.

Large banks in metropolitan areas, through their many local branches, can reap economies of scale. The existence of other large rival banks in an urban area fosters competition and drives banks to operate more efficiently. Weber and Devaney (1998) indicated that local banks in rural areas usually make only local loans and tend to be less

---

[27] This conclusion is based on a county-by-county comparison of two sets of banks operating in Texas. One set comprises small locally chartered banks. The second set comprises branches of large banks that

technically efficient due to small-scale operations. After the deregulation of interstate branching in 1997, Gilbert (1997, 2000) asserts that large banks with more resources are likely to expand into rural areas leading to greater competition and efficiency. However, there is another view by Gilbert and Belongia (1988) that argues that large banks, being able to diversify, may be less inclined to invest in agricultural loans. The entry of large banks into rural areas, therefore, may actually lower credit availability in rural areas.

Jayartne and Strahan (1996) found the liberalization of branch restrictions stimulates the rural economy by increasing competition. Featherstone (1996) observed that small rural banks are likely to be acquired by large banks specializing in agricultural loans. As a result, mergers and acquisitions do not affect the rural economy.

Although large banks in the future are likely to dominate rural areas, recent changes in banking regulation are favorable to small banks in reducing their regulatory burden. They are now allowed to expand into new businesses. Gilbert (1997) showed evidence that competition from new entrants of large banks would also compel small banks in the rural areas to operate more efficiently. As small rural banks specializing in agricultural loans had not been the primary targets of interstate mergers and acquisitions,

---

hold out-of-state charters.

Neff and Ellinger (1996) argued that those small rural agricultural banks can continue to retain the old agricultural business as well as expanding into consumer loans.[28]

The above-cited studies suggest that small banks might have comparative advantages, especially in the rural financial markets. Because of the profitability of small banks in the local financial markets, large banks are also attracted to enter those markets. The competitiveness of the local financial market will increase. Under these circumstances, operating efficiency will be an important issue for the survival of small banks. If small banks take advantage of their superior information in the local market and their increased flexibility, small banks may operate more efficiently than large banks. However, small banks are tied more closely to local economy. Thus, small banks operating in rural environments may be sensitive to agricultural production and prices within their local area. Figure 3 shows the managed assets of specialty loans of specialty banks. Loan specialization and local economic conditions are examined in this study. Therefore, this study investigates whether size matters to bank operating efficiency and survival value. The results will provide evidence on whether small banks will be victims of recent bank consolidation. The study will also examine the effect that specialization

---

[28] Belongia and Gilbert (1990) indicated that agricultural banking is profitable in general. They find that agricultural banks performed efficiently in agricultural lending, except during agricultural shocks. Agricultural shocks might cause some problems for those agricultural banks that are not well diversified in their loan portfolios.

has on bank efficiency by examining agricultural banks. This examination of the impact of specialization has not been done before.

3.4 Methodologies, Data, and Results

This essay examines the survival values of small banks by looking at their operating efficiency. Operational efficiency is examined for different types of bank structure, such as bank size, agricultural loan specialization, and charter location. We employ the X-efficiency methodology to measurement of the operating efficiency. Previous studies show that there are several ways to differentiate banks by size. We examine bank size using a new sorting criteria, which will be discussed in the following sections. The specification of the bank specialty and charter location will also be discussed in the following sections.

3.4.1 Estimation of Bank Efficiency

Berger, Hunter, and Timme (1993) surveyed different approaches to estimating bank efficiency. This study uses the measure of X-efficiency of Berger (1993) that measures a bank's operating efficiency relative to the most efficient bank.[29] To derive X-efficiency, a total cost function is first estimated for the average bank in a given year. Total cost is expressed as a function of output, and input prices. A standard translog function is used to estimate to total costs and derive the X-efficiency measure.

$$\ln TC_{ti} = a_0 + \sum_{k=1}^{6} b_k \ln(y_{kti}) + \sum_{l-1}^{4} a_l \ln(p_{lti}) + 0.5 \sum_{k=1}^{6} \sum_{j=1}^{6} b_{kj} \ln(y_{kti}) \ln(y_{jti})$$
$$+ 0.5 \sum_{l=1}^{4} \sum_{h=1}^{4} a_{lh} \ln(p_{lti}) \ln(p_{hti}) + \sum_{k=1}^{6} \sum_{l=1}^{4} d_{lk} \ln(y_{kti}) \ln(p_{lti}) + \ln(x_{ti}) + u_{ti}, \qquad (6)$$

where x_{ti} = X-efficiency factor

u_{ti} = random error

TC_{ti} = total costs of bank i at time t

y_k = bank outputs (1: real estate loans, 2: agricultural loans, 3: commercial and industrial loans, 4: personal loans, 5: deposit liability for transaction accounts, and 6: deposit liability for non-transaction accounts).

---

[29] Berger, Hunter, and Timme (1993), and Mester (1997) also apply the same methodology.

p_l = price inputs (1: total interest expenses 2: price of capital, 3: labor, and 4: federal funds rate).

Note that the joint effect of any two independent variables is captured with the product terms. The efficiency factor is captured in the residual term x_{ti} when individual bank data are applied to the regression results. Data used in equation (6) are taken from the Reports of Condition and Income Report Guide (Call Report). Commercial banks of charter number 200, 210, 250, or 340 and having issuer code and total assets greater than zero are included in the sample. This definition ensures that only commercial banks are included in the sample.

Cost-share equations of each input price can then be derived as follows:

$$\frac{\partial \ln TC_{ti}}{\partial \ln(p_{lti})} = S_{lti} = a_l + \sum_{h=1}^{4} a_{lh} \ln(p_{hti}) + \sum_{k=1}^{6} d_{lk} \ln(y_{kti}), \qquad (7)$$

Equations (6) and (7) are estimated subject to homogeneity and symmetry restrictions using the method of seemingly unrelated regressions (SUR). If a firm systematically incurs relatively higher costs than the other firms in a competitive environment, it is considered X-inefficient. In the survey conducted by Berger, Hunter, and Timme (1993), several econometric and linear programming techniques have been proposed for estimating X-efficiency, including the econometric frontier approach (EFA), the thick frontier approach (TFA), data envelopment analysis (DEA), and the distribution-free approach (DFA). In this study, assuming efficiency differences are stable, and the random error averages out over time, the distribution-free approach of Berger (1993) and DeYoung (1997) is used to estimate the efficiency of the banks. Peristiani (1997) shows that when we let $e_{ti} = \ln(x_{ti}) + u_{ti}$ and transform e_{ti} such that the minimum becomes 0; we arrive at the following:

$$\hat{e}_{ti} = \min\{\hat{e}_{ti}\} - \hat{e}_{ti}. \quad (8)$$

By taking the exponential of equation (8), X-efficiency is obtained.

$$XEFF_{ti} = \exp(\hat{e}_{ti}). \quad (9)$$

The X-efficiency of bank i at time t ($XEFF_{ti}$) is now normalized to fall between zero and one. Since $XEFF_{ti}$ is not robust to outliers, Berger (1993) modified the X-efficiency measure such that observations falling below the p-th percentile are set to the p-th percentile value ($\hat{e}_{ti}^{(p)}$), and observations exceeding the (1-p)-th percentile are set to ($\hat{e}_{ti}^{(1-p)}$). The modified X-efficiency can be defined as:

$$XEFF_{ti}(p) = \exp[\hat{e}_{ti}^{(p)} - \max\{\hat{e}_{t}^{(p)}, \min\{\hat{e}_{ti}, \hat{e}_{t}^{(1-p)}\}]. \quad (10)$$

3.4.2 Bank Size Specification

Banks are classified according to size, specialty and location based on the Federal Financial Institution Examination Council (FFIEC) form 031, 032, 033, and 034.[30] Banks with assets over $300 million are classified as large banks, $100 million to $300 million as medium banks and less than $100 million as small banks. However, according to the sample statistics in Panels A and B of Table 1 and Table 2, the sample is not normal distributed during the examination period. Because of the unique distribution of all U.S. commercial banks samples, it is hard to categorize banks by size. More than 2/3 of banks in the U.S. are below $150 million in total assets in the first quarter of 1988 and 1997.[31] On average, over the sample period, around 70% of the banks are small banks, 20% are medium banks, and 10% are large banks. In the largest size category, we also notice a large discrepancy. There are a cluster of extremely large banks with total assets in excess of $3 billion.

---

[30] The call report forms is split into four forms, 031 – 034, representing banks with domestic and foreign offices, banks with domestic offices only and total assets of $300 million or more, banks with domestic offices only and total assets of $100 million or more but less than $300 million, and banks with domestic offices only and total assets less than $100 million. Thus, in this study, the boundary of large, medium, and small banks are total assets of $300 million and $100 million. The cutoff of the larger banks, $300 million, is also consistent with the one that Jayaratne and Wolken (1999) employ.

[31] There are 86.95% and 76.95% of commercial banks are below $150 million in total assets in the first quarter of 1988 and 1997 respectively.

Several recent studies employed different approaches to classify different banks by size. Alam(2000) and Akhigbe and McNulty(2000) categorized large and small banks by using a cutoff of $500 million in total assets. Stiroh(2000) classified banks using more detailed categories.[32] In this study, two different approaches are used to differentiate different banks by size. The first uses FFIEC categorization and the second uses a modified version of the scale employed in Stiroh(2000).

If only few particular cutoffs of bank size are applied, bank growth might result in problems. For example, if steady growth of the banking industry is assumed, there will be an upward trend in bank size. Inflation issue might also be another issue that will affect bank size. However, Table 3, Panels A and B show, using two major indicators of inflation, that the inflation rate is not very high during our examination period. Thus, inflation might not be an important issue in discussing the bank size during our examination periods. Additionally, an upward bias of bank size might not exist because of the information exposure in the call report. Banks in different size categories have different reporting requirements from the FFIEC on the call report. For example, in the schedule RI-B of the call report, large banks, which have more than $300 million, have to release the details and itemize the charge-offs and recoveries on loans and leases and

---

[32] Stiroh(2000) classified bank size in different categories as follows: 200 million, 300 million, 500 million, 1 billion, and 5 billion.

changes in allowance for credit losses.[33] Small banks with less than $100 million in total assets only have to disclose the total amount of each item. Thus, banks in the small and medium size categories might have incentives to stay in the same categories in order to maintain the same level of information exposure. Thus, from this perspective, fix cutoffs of bank size through time might be appropriate.

To prevent a possible upward bias of the cutoffs of FFIEC, quartiles are also used to differentiate the bank size. Table 4 shows the cutoffs using the quartile criteria. Although using quartile criteria can solve the upward trend of the bank size, Figure 5 shows that the distribution of the first and second quartile may still be biased.[34] For example, in the first quartile, some banks are extremely large with size more than 10 billion dollars in total assets.

In order to capture the effect of bank size in more detail, the criteria that we use to differentiate banks by size is to use the following categories: 10 million, 20 million, 30 million, 40 million, 50 million, 60 million, 70 million, 80 million, 90 million, 100 million, 150 million, 200 million, 250 million, 300 million 400 million, 500 million, 600

---

[33] Schedule RI-B in the call report is the form for banks to disclose information related to charge-offs recoveries on loans and leases and change in allowance for credit losses. In this schedule, medium- and small-size banks have the same information exposure. However, one of the major differences to large banks is the requirement to categorize each item into the U.S. and non-U.S. operations. Large banks also have to release information on the amount of credit cards and related plans for loans to individuals for household, family, and other personal expenditures.

million, 700 million, 800 million, 900 million, 1 billion, 1.5 billion, 2 billion, 3 billion, 5 billion, and 10 billion dollars and above. This categorization allows bank efficiencies be addressed more accurately and the testing results will not be distorted because of the non-normality in the distribution of bank size.

3.4.3 Specifications of Banks' Loan Specialization and Charter Location

To determine loan specialization, the criteria used in Ellinger (1994) and Gilbert and Kliesen (1995) is applied. Banks with a ratio of agricultural loans to total loans of more than 25% are classified as agricultural banks and less than 25% as nonagricultural banks. Banks are placed into two categories based on their charter location, MSAs (metropolitan statistical areas) and non-MSAs. We assume that commercial banks focus more on the urban market when their charter location is in a MSAs and that commercial banks in non-MSAs target their customers in rural areas.

As to the specifications of bank size, loan specialization, and charter location, three major statistical tests are conducted. First, tests of economies of scale are conducted in two different ways, pairwise comparison tests and regression analysis.

---

[34] The banks categorized in the first quartile are the those with total assets more than Q3 in Table 4. The second quartile is between Q3 and Q3.

Secondly, the relationship between bank efficiency and agricultural output at the county level is examined. Third, the relationship between the price risks of agricultural products and bank efficiency is examined.

3.4.4 Economies of Scale Tests

3.4.4.1 Efficiency Comparison Tests

Commercial banks will have efficiency differences across size, loan specialties, and charter location. We hypothesize that the commercial banks with agricultural specialties might have superior performance relative to the ones without agricultural specialties, that commercial banks in MSAs may operate more efficiently than the ones in non-MSAs, and large commercial banks may outperform smaller banks because of scale economies. Therefore, pairwise comparison tests are proposed to test the bank efficiency based on different bank size, charter location and loan specialization criteria.

Banks are categorized according to their size, charter location, and specialty. Permutations of the three factors result in a total of 12 categories. Table 5 shows the number of observations in each category. The study period covers 1988 through 1997 for all regions of the U.S.

As discussed in section 3.4.2, the criteria used to categorize banks by size are controversial. Although categorizing bank size in more detail might provide more accurate information, a lack of observations might be a problem for comparisons in certain categories. In order to prevent the bias of unequal variance in the different categories, the Cochran and Cox approximation of the probability level of the approximate *t* statistic is employed. We examine both the FFIEC and our modified version of Stiroh's (2000) size cutoffs.

Statistics of banks' efficiency categorized by the different criteria are shown in Table 6. Most of the observations are small banks, which have \$100 million or less than \$100 million in total assets. On average, only around one fifth of the banks are regarded as agricultural banks. However, the number of banks chartered in MSAs is similar to that in non-MSAs. Considering the bank size, loan specialization, and charter location jointly, most banks are urban, non-agricultural banks in the categories of large- and medium-size banks. However, non-agricultural banks chartered in non-MSAs dominate in the small-size category. The comparison results of bank X-efficiency for the 12 categories of banks are shown in Table 7. Table 7 indicates that large banks dominate in efficiency, but medium banks are not more efficient than small banks. Metropolitan banks are superior to non-metropolitan banks while nonagricultural banks are more efficient than agricultural banks. Greater competition due to bank density in metropolitan areas and the uncertainty and volatility in agricultural lending seem to exert major influence on bank efficiency. As to the comparisons based on the bank's size shown in Table 8, banks chartered in MSAs always outperform those chartered in non-MSAs, except for medium sized banks. From the perspective of the agricultural loan specialization, agricultural banks operate more cost efficiently than non-agricultural banks in the medium and small size categories.

Comparisons based on loan specialization and charter location in Table 9, there are no economies of scale in the banks with agricultural loan specialization. Medium size appears to be the optimal size for the banks with loan specialties in agriculture to operate most efficiently. Large banks operate the least efficiently in the specialty of agricultural lending. Those banks without agricultural loan specialization still have economies of scale in cost efficiency. However, the results based on the charter location are ambiguous. Large banks still operate most efficiently in both MSAs and non-MSAs. Banks chartered in MSAs in medium size are least efficient among all banks. Yet, medium banks chartered in non-MSAs have the same cost efficiency as large banks.

In order to inspect the efficiency of banks more appropriately, banks are broken into smaller size categories, with cutoffs of $10 million, $20 million, $30 million, $40 million, $50 million, $60 million, $70 million, $80 million, $90 million, $100 million, $150 million, $200 million, $250 million, $300 million $400 million, $500 million, $600 million, $700 million, $800 million, $900 million, $1 billion, $1.5 billion, $2 billion, $3 billion, $5 billion, and $10 billion dollars and above. The averages of X-efficiency in every size categories are obtained. Figure 6 shows economies of scale do exist in the banking industry. The larger the size of banks, the more cost efficient they are. However, this is not the case if the sample size is split into categories based on loan specialization and charter location. Interestingly, economies of scale do not apply to the banks with loan specialization in agriculture (Figure 7 and Figure 8). Actually, there is an optimal size for banks with agricultural specialties. Figure 9 and Figure 10 show that economies of scale exist for banks in MSAs and non-MSAs.

In addition to the comparison based on the cutoff of FFIEC, the comparisons between banks with loan specialization and without loan specialization in detail size categories are also conducted. The comparisons in the detailed size categories are to determine whether agricultural banks do operate efficiently than non-agricultural banks in certain size range as suggested by Figure 7 and Figure 8.

The results on Table 8 and Table 9 show that medium-size banks with agricultural specialization outperform banks with non-agricultural loan specialization. However, the size criteria used in Table 8 and Table 9 are based on the cutoffs in the call report. It is hard to tell where the exact range in which agricultural banks outperform non-agricultural banks. Thus, tests of the more detailed size categories are necessary. In Table 10, the results show that there is a specific range of bank size in which agricultural banks outperforming non-agricultural banks. Between $20 million and $250 million in total assets, agricultural banks operate more efficiently than non-agricultural banks. These results are consistent with the results found using the FFIEC cutoffs in Table 8 and Table 9. Thus, non-existence of economies of scale in banks with agricultural loan specialization is further proven in this test. This also provides evidence to suggest that loan specialization may benefit smaller sized banks and that there is an optimal size at which loan specialization is effective. This leads support to the idea that smaller banks do have a valuable survival value and that small banks may survive in environments of banking consolidation.

3.4.4.2 Regression Analysis

To study the impact of agricultural factors and scale economy on bank efficiency, the X-efficiency of banks is regressed on bank size and selected agricultural factors. Three models, the basic fundamental information, the local economic activity effects, and the agricultural products price risk effects, are examined. The fundamental model is examined in this section.

The purpose of the fundamental model is to examine economies of scale of banks and seasonal effects on bank X-efficiency. Due to the unique distribution of all samples, a square term and a cube term for bank size are added to test whether there are really economies scale in bank efficiency. The following regression model is estimated for both agricultural and non-agricultural banks:

$$XEFF_i = a + b_1 size_i + b_2 size^2_i + b_3 size^3_i + b_4 AAR_i + b_5 Inter_i + b_6 bkcapital_i + b_7 Agprice_i + \sum_{j=1}^{3} g_j q_j , \qquad (11)$$

where size = size of the bank, measured by the log of total assets. Squared and cubed terms for size are also applied to capture of the feature of non-linearity in economies of scale. Based on the results shown in Figure 6 to Figure 10, the relationship between bank efficiency and the bank size is not linear. Thus, the square and cube terms of the size should pick up this observed non-linearity.

AAR = average agricultural loan ratio, calculated from average agricultural loans divided by total assets. This variable is used to classify the bank with loan specializations in agriculture.

Inter = interaction term, testing the relationship between agricultural lending and the bank's size. If this term is positive, banks with loan specialization might not have economies of scale.

Bkcapita = banks per capita of the county level, measured as the ratio of the number of commercial banks chartered in the county to the population of the county. This measure is designed to capture bank competitiveness at the county level. The Census of Population is used to develop this measure. Because of the availability of only 1980, 1990, and 1999 population data, we assume the growth rate at the county level is steady. Thus, the quarterly population at the county level is obtained in proportion to the change of the data in the years for which census data is available. The sign of the coefficient of this variable is expected to be positive because of the increasing level of competitiveness within the banking industry.

Agprice = volatility of agricultural loans based on the quarterly data of average agricultural loans over the 10-year examination period. If the proportion of agricultural lending fluctuates through time, the uncertainty in the bank increases. Operational efficiency is expected to decline because of the uncertainty. Therefore, the volatility of agricultural loans is expected to have negative impact on bank efficiency.

qj = dummy variables measuring seasonal effect. q1 represents the dummy of the first quarter, q2 represents the dummy of the second quarter, and q3 represents that of the third quarter. The intercept term measures the effect of the fourth quarter.

$XEFF_i$ = quarterly efficiency of each commercial bank over 1988-1997 period.

Data for dependent and independent variables come from the Call Report, except banks per capita (Bkcapita).

The regression analysis will also be divided individually into 27 individual size categories. Thus, regardless of the size effect, detailed information of the impact on bank efficiency caused by bank fundamental information can be observed. Because of the size effect has been considered by doing regression analysis in the smaller size categories, the model is revised as follows:

$$XEFF_i = a + b_1 AAR_i + b_2 bkcapita_i + b_3 Agprice_i + \sum_{j=1}^{3} g_j q_j \qquad (12)$$

Results for equation (11), estimated using all banks, are shown in Table 10. The sign of the size and size^3 variables are significant and negative, which the square term is positively significant. The results are consistent with those in Figure 6 and with previous studies.

The average agricultural loan ratio has a significant negative impact on banks' cost efficiency. This means that the higher the level of agricultural loans, the lower cost efficiency. However, the interaction (Inter) between the agricultural loans and bank size (AAR * size) has significant positive influence on bank efficiency. The dynamic relationship implies there might be an optimal size for banks with an agricultural specialty. Figure 7 shows evidence of the regression results. Banks with agricultural specialization operate most efficiently in the optimal size range between 90 million and 400 million dollars in total assets.

Banks per capita (Bkcapita) is regarded as a proxy of the competitiveness of banks in the local financial market. Bkcapita has positive influence on bank efficiency. Increasing competition in the local financial market increases the cost efficiency of the bank. However, the volatility of agricultural loans (Agprice) influences bank efficiency negatively. In the other words, stability in the agricultural lending environment might improve the cost efficiency of the bank. Other than those fundamental factors, seasonal effects also are tested. The results shows seasonal effects do exist. The fluctuations of loan demand might depend on the seasons. The seasonal effects might be also caused by macro economy. The correlation coefficient matrixes are included in the results as a check for possible multicollinearity based on the observations that we use in the model. The results are shown in Table 12, Table 13, and Table 14. The results show that the correlation among the dependent variables, except for size, $size^2$ and $size^3$, are low.

3.4.4.3 Local Economic Activity Effects

Since this study focus on the cost efficiency of banks specializing in agriculture, agricultural production at the county level is regarded as a proxy for the local economic factors. Thus, agricultural production may impact the efficiency of agricultural banks. Agricultural productions at county level are included into the fundamental information model to test local economic effects on bank efficiency. According to the criteria in Table 15, agricultural products are categorized into ten sectors. They are food grains, feed grains and hay, cotton, tobacco, oil-bearing crops, all fruit and nuts, commercial vegetables, meat animals, dairy products, and poultry and eggs. In order to calculate the proportion of agricultural loans to specific agricultural products, we assume that the product of the average agricultural loan ratio (AAR) and the specific agricultural product ratio among all agricultural products can be regarded as the level agriculture lending to specific agricultural products of the individual bank. Agricultural products ratios at county level are available from the 1992 Census of Agriculture.[35] Thus, the model showing the relationship between bank efficiency and various agricultural factors is examined on equation (13). The dependent and independent variables are the quarterly average of data between 1988 and 1992 because of the availability of agricultural data. Furthermore, we examine the relationship between agricultural price change from 1987 to 1992 and X-efficiency change from 1988 to 1992 is examined. The future change of bank efficiency from 1992 to 1997 is examined to see if it is influenced by the change of agricultural factors from 1988 to 1992. The above two models, which examine the impacts of the change of agricultural factors on the simultaneous and future changes of bank efficiency, are shown on equation (14).

$$\begin{aligned} XEFF_i = a + b_1 size_i + b_2 size^2{}_i + b_3 size^3{}_i + b_4 AAR_i + b_5 Inter_i + b_5 bkcapita_i \\ + b_6 Agprice_i + \sum_{j=1}^{10} r_j (AgR_{ji} * AAR_i). \end{aligned} \tag{13}$$

$$\begin{aligned} \Delta XEFF_i = a + b_1 \Delta size_i + b_2 \Delta AAR_i + b_3 \Delta Inter_i + b_4 \Delta bkcapita_i + b_5 Agprice_i \\ + \sum_{j=1}^{10} r_j \Delta (AgR_{ji} * AAR_i) \end{aligned} \tag{14}$$

---

[35] In the Census of Agriculture, agricultural products data are available based on unit, price, land size, and farm numbers. Because of the variety of units of agricultural products, we calculate the agricultural product ratios based on price. Farm size is not an appropriate proxy. The production of one acre of tobacco is different from that of one acre of vegetables. Because the census is formed by the voluntary submission of information, the number of farms is not representative of all production. Thus, the value of

In order to understand the impact of agricultural factors on banks in different size categories, the model similar with equation (13) is also conducted to observe the agricultural effect of the smaller size categories. Due to the level of diversification of loan portfolios, agricultural factors are expected to have more explanatory power on small banks than on large banks. The equation can be obtained as follows:

$$XEFF_i = a + b_1 AAR_i + b_2 bkcapital_i + b_3 Agprice_i + \sum_{j=1}^{3} g_j q_{ji} + \sum_{j=1}^{10} r_j (AgR_{ji} * AAR_i) \qquad (15)$$

The results are split into three groups, all observations, agricultural banks, and non-agricultural banks. This will allow us to determine the specific impact of agricultural factors on agricultural banks. Table 16 shows the results on equation (13). The correlation matrixes of the model based on different observations are shown in Table 17, Table 18, and Table 19. The results in Table 16 show that bank size has positive effect at 1% significance level on bank X-efficiency in all three different categories based on all banks', agricultural banks', and non-agricultural banks' observation. Average agricultural loans have the same effect as well. Interaction term (Inter), the product of bank size and agricultural loans, is 1% positive significant. However, only agricultural

---

sale of agricultural products in dollars will be more appropriate to measure the ratio of agricultural products in a given county.

loan volatility has negative impact on bank efficiency at 1% significance level. Because agricultural banks more rely on agricultural loans, the volatility of agricultural loans play a more important role in agricultural banks than non-agricultural banks. As to agricultural factors, food grain is only positive significant on all banks' observations. Feed grains and hay, tobacco, oil-bearing crop, meat animals, and diary products are all positive significance on bank efficiency. Fruit and nuts and vegetable, which are regarded as commercial agricultural products, have negative significant impact on only agricultural bank efficiency. Usually, those commercial agricultural products have higher profit margin than other crops. As to the demand and supply theory, more supply may make price and profit margin lower. Thus, the higher production of those products, the lower profits they will be. The probability to pay off agricultural loans may be lower. Indirectly, it affects cost of bank operation, which has higher portion of agricultural loans. Thus, the higher production of fruit, nuts, and vegetable only affect agricultural bank X-efficiency negatively. On the other hand, cotton, poultry and eggs affect non-agricultural banks efficiency positively. Those products are more relative to urban lives. The higher production of cotton, poultry, and egg may drive the price down and reduce the costs of industrial production, which are the major target customers of non-agricultural banks. Thus, the lower production costs may directly increase the probability of industrial borrowers to payoff the loans. Thus, the cost efficiency of non-agricultural banks increases. As to the adjusted R Square, the results show that our model has more predictability on agricultural banks than on non-agricultural banks.

Table 20 shows the results of relationship between percentage change of bank efficiency between 1988 and 1992 periods and percentage change of agricultural factors between 1988 and 1992 periods on equation (14). The results are split into three categories, based on different banks' observations. Table 21, Table 22, and Table 23 show the matrixes of correlation of those independent variables. Percentage change of bank size has positive effect in all three categories. However, interaction term (Inter), product of bank size and agricultural loans, has negative significant impact on all banks' and non agricultural banks' efficiencies. It implies that the increase of agricultural loan ration decrease all banks' and non-agricultural banks' efficiency. The competitiveness of local financial market does not enhance bank efficiency. The volatility of agricultural loans has significant impact on bank efficiency. It positively affects all bank and non-agricultural bank efficiencies, but negatively affect agricultural efficiency, which is consistent with the previous results. As to the percentage changes of agricultural factors, generally, changes of agricultural factors have more impacts on agricultural banks. The percentages change of food grains, feed grains and hay, cotton, fruit and nuts, meat animals, diary products, and poultry and eggs influence agricultural bank efficiency negatively. However, the percentage change of tobacco has positive effect, which is the reverse result on non-agricultural banks. .

We also test whether post information of percentage change of bank fundamental information and agricultural factors affect the future percentage change of bank efficiency by using the same equation on equation (14). The percentage change of bank efficiency between 1992 and 1997 regresses on the percentage changes of banks' fundamental information and agricultural factors between 1988 and 1992. Table 24 shows that the percentage change of banks' fundamental information and agricultural factors do not affect much the future performance of bank operation. According to R Squares of the model, the changes of agricultural factors have poor predictability of bank future efficiency change. Table 25 shows the results of the relationship between bank efficiency change from 1988 to 1997 and changes of bank's fundamental information and agricultural factors from 1988 to 1992. The results are similar with those in Table 20. However, interaction term (inter) is not significant on agricultural banks. The percentage change of tobacco is not significant on agricultural banks, too. The R Squares are also consistent with previous results that the model using agricultural banks' observations has higher adjusted R Square.

3.4.4.4 Agricultural Products Price Risk Effects

If the bank's loan portfolios put too much weight on a specific leading specialization, bank-operating costs will solely depend on the local economic activities related to the bank's lending specialty. Thus, economic fluctuation will affect bank's efficiency in some circumstances. Diversification of loan portfolios might be an important issue to bank efficiency. However, because of the innovation of financial markets, there are several financial instruments for hedging the risk in the commodity market, such as futures contracts. We assume banks take advantage of futures contracts to hedge risk. Therefore, the diversification of loan portfolios might not be an issue.

In addition to agricultural price as a proxy for agricultural factors, the price volatility of agricultural products is also considered in this model. Price volatilities of the agricultural products (AgPV), shown in Table 26, are calculated from the price index of each agricultural category at the national level to proxy for the price risk of the agricultural products. The indexes for agricultural products are available from the USDA Statistical Bulletin. A dummy variable (DumFC) is designed to represent the availability hedging opportunities by the bank using agricultural commodity futures contracts. Although agricultural banks with higher agricultural loans and less diversified loan portfolios might have higher risk exposure, banks can employ hedges to minimize price risk in order to prevent losses from agricultural shocks.

The rationale for the hedging variable is as following. If there is commodity in production at the county level and a futures contract on the commodity is also available, the bank could require the borrower to engage in a future contract to hedge the position.[36] The dummy is defined as zero in this situation as all risk would be hedged. If the commodity is not available at the county level, the bank makes no loans on such commodities, it is not essential for banks to require borrowers to hedge. Hence, the dummy in this situation is zero as well. If the commodity is available but the future contract is not traded, banks have a risk exposure without any risk hedging. The dummy

[36] Farmers would be short in the futures contract.

is one in this case, represented the presence of an unhedged price risk. Table 27 summarizes the design of the dummy variable. Table 28 shows the futures contracts that are available for commodities. Therefore, if there is a risk exposure in the particular agricultural product, the volatility of the price should matter. The interaction terms of agricultural price volatility and the futures contract dummy variable (AgPV*DumFC) represents the price risk of the agricultural products. The model considering agricultural price risk is given in equation (16). Because of the availability of agricultural data, a test is done by using quarterly average of bank X-efficiency and quarterly average of banks' fundamental information and agricultural factors in 1992 based on three different observation categories.

$$
\begin{aligned}
XEFF_i &= a + b_1 size_i + b_2 size^2{}_i + b_3 size^3{}_i + b_4 AAR_i + b_5 Inter_i + b_5 bkcapital_i \\
&\quad + b_6 Agprice_i + \sum_{j=1}^{10} r_j (AgR_{ji} * AAR_i) + \sum_{j}^{10} w_j (AgPV_{ji} * DumFC_{ji})
\end{aligned} \tag{16}
$$

Table 29 shows the results on equation (16). Interestingly, size effect is not consistent with the previous results. Bank size has negative significant effect on all banks', agricultural banks', and non-agricultural banks' efficiencies. Average agricultural loans ratio has the same negative impact as well. However, interaction term (inter), the product of bank size and agricultural loan ratio, has positive influence in three categories. The proxy of local financial market competitiveness has positive impact on bank efficiency. The result of agricultural loan volatility (Agprice) is consistent with previous result. It (Agprice) negatively affects agricultural banks' efficiency. As to agricultural factors, feed grains and hay, oil-bearing crop, and diary products have positive impacts on banks' efficiency based on different observation categories. Tobacco, meat animals, and poultry and eggs have positive significant effects on non-agricultural banks' efficiency instead of agricultural banks'. Although loans to tobacco production do not significantly affect agricultural banks' efficiency, fluctuation of tobacco price does have impact on not only on all bank and non-agricultural banks but agricultural banks. However, the situation for the fruit and nuts and vegetable is different. The loans to fruit and nuts and vegetables have significantly negative impact on agricultural banks. However, the price risks of fruit and nuts and vegetable also have insignificantly negatively impact on agricultural banks. Because agricultural banks are specialized in agricultural lending, they are sensitive to the production of those commercial products, like fruit and nuts and vegetable. Although there are no futures contract to hedge the risk, agricultural banks have more insider information than non-agricultural banks. Thus, agricultural banks may have more ability to protect from the price risk of fruit and nuts and vegetable. As to the adjusted R Squares, the results are also consistent with the previous results and our expectation. The model examined by using agricultural banks' observations has more explanatory power than by using all banks' and non-agricultural banks' observation.

According to the previous hypotheses, we also examine previous models by using detailed size categories. The results of bank fundamental information effect model, local economic activity effect model, and agricultural price risk effect model in detailed size categories are shown in Table 30. In general, models examined by using agricultural banks' observations have higher adjusted R Squares than by using all banks' and non-agricultural banks' observations. Especially in the local economic activity effect model and agricultural price risk effect model, agricultural factors have more explanatory power on agricultural banks' efficiency. Agricultural banks with 70 to 90 million dollars in total assets have the highest adjusted R Square among those tests.

3.5 Conclusions

In this study, we investigate two effects on bank efficiency by employing X-efficiency and agricultural factors at the county level. First, we examine if bank's size, charter location, and lending specialties explain differences in X-efficiency across commercial banks. We do find support for the hypothesis that bank's size, charter location, and loan specialties play an important role in determining efficiency in the banking industry. Between 1988 and 1997, large commercial banks operate more cost efficiently than other smaller commercial banks. Non-agricultural commercial banks and commercial banks chartered in MSAs also outperform agricultural commercial banks and commercial banks chartered in non-MSAs. If the bank's size, charter location, and lending specialties considered jointly, large and small non-agricultural commercial banks chartered in MSAs have the highest X-efficiency in those specific categories. Only in the medium-sized commercial bank category do non-agricultural commercial banks chartered in non-MSAs outperform medium-sized commercial banks in non-MSAs. Overall, we can conclude that commercial banks chartered in MSAs without agricultural specialties operate most efficiently. There is no difference in X-efficiency between agricultural commercial banks in MSAs and non-MSAs. Interestingly, agricultural commercial banks operate less efficiently than do non-agricultural commercial banks in non-MSAs. The results show that economies of scale in commercial banks do exist. However, in the perspective of the bank's loan specialization, it is not necessary that the bank's size should be large to be efficient.

The results show that there is an optimal size for banks with a loan specialization. Banks with loan specialization in agricultural lending are more efficient within the size range of 80 million to 400 million dollars in total assets. This implies that smaller banks do have survival value in terms of cost efficiency. It is not necessary for specialty banks to be large to be efficient. Regulators also do not have to worry about the survival problem and competition of the smaller banks. Banks without large asset size but with agricultural loan specialization are expected to remain competitive in the local market. As long as those smaller banks still exist and perform well after the deregulation in the banking industry, the local financial market will remain competitive and the worry of the lack of adequate credit source might be redundant.

Our second test is that the X-efficiency of commercial banks may be influenced by agricultural factors. We investigate the relationship between the X-efficiency of commercial banks and agricultural factors from the 1992 Census of the Agriculture at the county level. We find that agricultural factors do affect the cost efficiency of commercial banks. Interestingly, non-agricultural commercial banks are also influenced by agricultural factors. Thus, agricultural factors might be one of the considerations in the evaluation of the commercial banks' X-efficiency, especially for small-sized commercial banks. The X-efficiencies of large-sized commercial banks are not shown to be affected by agricultural factors. Large-sized commercial banks may depend less on local economic activities or price change, thus, eliminating their dependence on agricultural activity.

TABLE 1. STATISTICS OF U.S. COMMERCIAL BANKS IN DIFFERENT CATEGORIES

This table contains numbers (Panel A) and percentages (Panel B) of banks in different categories by quarter from 1988 to 1997. L: Large banks with total assets not less than $300 million. M: Medium banks with total assets between $300 and $100 million. S: Small banks with total assets below $100 million. A: Agricultural banks with agricultural loan ratio not less than 25 percent of total assets. NA: Non-agricultural banks M' & NM': Banks chartered in MSA and non-MSA.

PANEL A: NUMBER OF COMMERCIAL BANKS IN DIFFERENT CATEGORIES

Quarter/Year	All banks	L	M	S	A	NA	M'	NM'
01/88	13493	895	1837	10761	2219	11274	6230	7263
02/88	13362	902	1869	10591	2341	11021	6138	7224
03/88	13188	909	1861	10418	2338	10850	6036	7152
04/88	13071	930	1899	10242	2198	10873	5965	7106
01/89	12951	908	1906	10137	2087	10864	5896	7055
02/89	12901	927	1932	10042	2219	10682	5891	7010
03/89	12778	946	1949	9883	2272	10506	5820	6958
04/89	12658	965	2017	9676	2160	10498	5770	6888
01/90	12547	970	2011	9566	2066	10481	5712	6835
02/90	12456	975	2027	9454	2189	10267	5652	6804
03/90	12362	986	2046	9330	2216	10146	5605	6757
04/90	12298	1007	2080	9211	2130	10168	5574	6724
01/91	12205	994	2075	9136	2076	10129	5521	6684
02/91	12108	1010	2067	9031	2204	9904	5465	6643
03/91	12025	1014	2090	8921	2245	9780	5405	6620
04/91	11872	1019	2102	8751	2140	9732	5299	6573
01/92	11759	1019	2126	8614	2054	9705	5238	6521
02/92	11638	1012	2118	8508	2177	9461	5163	6475
03/92	11545	1017	2137	8391	2180	9365	5124	6421
04/92	11424	1030	2141	8253	2023	9401	5265	6159
01/93	11290	1012	2103	8175	1915	9375	5178	6112
02/93	11161	1002	2106	8053	2004	9157	5096	6065
03/93	11047	1015	2132	7900	2060	8987	5023	6024
04/93	10933	1024	2141	7768	1977	8956	4930	6003
01/94	10816	1029	2134	7653	1869	8947	4859	5957
02/94	10694	1026	2129	7539	1977	8717	4779	5915
03/94	10566	1035	2142	7389	2000	8566	4710	5856
04/94	10424	1040	2148	7236	1830	8594	4648	5776
01/95	10212	1022	2093	7097	1740	8472	4538	5674
02/95	10142	1049	2129	6964	1806	8336	4533	5609
03/95	10025	1074	2146	6805	1833	8192	4465	5560
04/95	9914	1081	2198	6635	1695	8219	4434	5480
01/96	9807	1088	2164	6555	1588	8219	4376	5431
02/96	9660	1047	2169	6444	1680	7980	4283	5377
03/96	9556	1060	2187	6309	1662	7894	4231	5325
04/96	9498	1085	2234	6179	1570	7928	4220	5278
01/97	9417	1087	2214	6116	1439	7978	4177	5240
02/97	9266	1041	2214	6011	1533	7733	4088	5178
03/97	9177	1040	2190	5947	1544	7633	4053	5124
04/97	9101	1058	2225	5818	1479	7622	4023	5078

PANEL B: PERCENTAGE OF COMMERCIAL BANKS IN DIFFERENT CATEGORIES IN THE UNITED STATES

Qt/Yr	L	M	S	A	NA	M'	NM'
01/88	6.63%	13.61%	79.75%	16.45%	83.55%	46.17%	53.83%
02/88	6.75%	13.99%	79.26%	17.52%	82.48%	45.94%	54.06%
03/88	6.89%	14.11%	79.00%	17.73%	82.27%	45.77%	54.23%
04/88	7.11%	14.53%	78.36%	16.82%	83.18%	45.64%	54.36%
01/89	7.01%	14.72%	78.27%	16.11%	83.89%	45.53%	54.47%
02/89	7.19%	14.98%	77.84%	17.20%	82.80%	45.66%	54.34%
03/89	7.40%	15.25%	77.34%	17.78%	82.22%	45.55%	54.45%
04/89	7.62%	15.93%	76.44%	17.06%	82.94%	45.58%	54.42%
01/90	7.73%	16.03%	76.24%	16.47%	83.53%	45.52%	54.48%
02/90	7.83%	16.27%	75.90%	17.57%	82.43%	45.38%	54.62%
03/90	7.98%	16.55%	75.47%	17.93%	82.07%	45.34%	54.66%
04/90	8.19%	16.91%	74.90%	17.32%	82.68%	45.32%	54.68%
01/91	8.14%	17.00%	74.85%	17.01%	82.99%	45.24%	54.76%
02/91	8.34%	17.07%	74.59%	18.20%	81.80%	45.14%	54.86%
03/91	8.43%	17.38%	74.19%	18.67%	81.33%	44.95%	55.05%
04/91	8.58%	17.71%	73.71%	18.03%	81.97%	44.63%	55.37%
01/92	8.67%	18.08%	73.25%	17.47%	82.53%	44.54%	55.46%
02/92	8.70%	18.20%	73.11%	18.71%	81.29%	44.36%	55.64%
03/92	8.81%	18.51%	72.68%	18.88%	81.12%	44.38%	55.62%
04/92	9.02%	18.74%	72.24%	17.71%	82.29%	46.09%	53.91%
01/93	8.96%	18.63%	72.41%	16.96%	83.04%	45.86%	54.14%
02/93	8.98%	18.87%	72.15%	17.96%	82.04%	45.66%	54.34%
03/93	9.19%	19.30%	71.51%	18.65%	81.35%	45.47%	54.53%
04/93	9.37%	19.58%	71.05%	18.08%	81.92%	45.09%	54.91%
01/94	9.51%	19.73%	70.76%	17.28%	82.72%	44.92%	55.08%
02/94	9.59%	19.91%	70.50%	18.49%	81.51%	44.69%	55.31%
03/94	9.80%	20.27%	69.93%	18.93%	81.07%	44.58%	55.42%
04/94	9.98%	20.61%	69.42%	17.56%	82.44%	44.59%	55.41%
01/95	10.01%	20.50%	69.50%	17.04%	82.96%	44.44%	55.56%
02/95	10.34%	20.99%	68.66%	17.81%	82.19%	44.70%	55.30%
03/95	10.71%	21.41%	67.88%	18.28%	81.72%	44.54%	55.46%
04/95	10.90%	22.17%	66.93%	17.10%	82.90%	44.72%	55.28%
01/96	11.09%	22.07%	66.84%	16.19%	83.81%	44.62%	55.38%
02/96	10.84%	22.45%	66.71%	17.39%	82.61%	44.34%	55.66%
03/96	11.09%	22.89%	66.02%	17.39%	82.61%	44.28%	55.72%
04/96	11.42%	23.52%	65.06%	16.53%	83.47%	44.43%	55.57%
01/97	11.54%	23.51%	64.95%	15.28%	84.72%	44.36%	55.64%
02/97	11.23%	23.89%	64.87%	16.54%	83.46%	44.12%	55.88%
03/97	11.33%	23.86%	64.80%	16.82%	83.18%	44.16%	55.84%
04/97	11.63%	24.45%	63.93%	16.25%	83.75%	44.20%	55.80%

TABLE 2. DISTRIBUTION OF BANKS BASED ON BANK'S SIZE

This table contains the distribution of banks by size, as measured by total assets, for the first quarter of 1988 (Panel A) and the first quarter of 1997 (Panel B). Both the frequency and relative percentage are shown.

PANEL A. DISTRIBUTION OF ALL BANKS BASED ON SIZE IN THE FIRST QUARTER OF 1988

Size	Freq	%	Size	Freq	%	Size	Freq	%	Size	Freq	%
<10M	970	7.19	790-810M	4	0.03	1.59-1.61B	2	0.01	2.39-2.41B	1	0.01
10-30M	4374	32.41	810-830M	5	0.04	1.61-1.63B	1	0.01	2.41-2.43B	1	0.01
30-50M	2600	19.27	830-850M	6	0.04	1.63-1.65B	1	0.01	2.43-2.45B	0	0
50-70M	1592	11.8	850-870M	1	0.01	1.65-1.67B	2	0.01	2.45-2.47B	1	0.01
70-90M	873	6.47	870-890M	10	0.07	1.67-1.69B	1	0.01	2.47-2.49B	0	0
90-110M	600	4.45	890-910M	8	0.06	1.69-1.71B	4	0.03	2.49-2.51B	2	0.01
110-130M	417	3.09	910-930M	2	0.01	1.71-1.73B	2	0.01	2.51-2.53B	0	0
130-150M	306	2.27	930-950M	6	0.04	1.73-1.75B	1	0.01	2.53-2.55B	1	0.01
150-170M	217	1.61	950-970M	9	0.07	1.75-1.77B	2	0.01	2.55-2.57B	0	0
170-190M	153	1.13	970-990M	5	0.04	1.77-1.79B	0	0	2.57-2.59B	0	0
190-210M	138	1.02	990-1010M	4	0.03	1.79-1.81B	0	0	2.59-2.61B	2	0.01
210-230M	121	0.9	1.01-1.03B	6	0.04	1.81-1.83B	1	0.01	2.61-2.63B	0	0
230-250M	85	0.63	1.03-1.05B	3	0.02	1.83-1.85B	3	0.02	2.63-2.65B	0	0
250-270M	65	0.48	1.05-1.07B	10	0.07	1.85-1.87B	7	0.05	2.65-2.67B	2	0.01
270-290M	58	0.43	1.07-1.09B	2	0.01	1.87-1.89B	6	0.04	2.67-2.69B	0	0
290-310M	51	0.38	1.09-1.11B	6	0.04	1.89-1.91B	0	0	2.69-2.71B	0	0
310-330M	56	0.41	1.11-1.13B	6	0.04	1.91-1.93B	3	0.02	2.71-2.73B	4	0.03
330-350M	37	0.27	1.13-1.15B	4	0.03	1.93-1.95B	3	0.02	2.73-2.75B	2	0.01
350-370M	37	0.27	1.15-1.17B	4	0.03	1.95-1.97B	1	0.01	2.75-2.77B	3	0.02
370-390M	35	0.26	1.17-1.19B	5	0.04	1.97-1.99B	0	0	2.77-2.79B	1	0.01
390-410M	35	0.26	1.19-1.21B	4	0.03	1.99-2.01B	0	0	2.79-2.81B	0	0
410-430M	22	0.16	1.21-1.23B	2	0.01	2.01-2.03B	1	0.01	2.81-2.83B	1	0.01
430-450M	31	0.23	1.23-1.25B	7	0.05	2.03-2.05B	1	0.01	2.83-2.85B	0	0
450-470M	24	0.18	1.25-1.27B	5	0.04	2.05-2.07B	3	0.02	2.85-2.87B	2	0.01
470-490M	28	0.21	1.27-1.29B	2	0.01	2.07-2.09B	2	0.01	2.87-2.89B	2	0.01
490-510M	14	0.1	1.29-1.31B	1	0.01	2.09-2.11B	1	0.01	2.89-2.91B	1	0.01
510-530M	8	0.06	1.31-1.33B	2	0.01	2.11-2.13B	0	0	2.91-2.93B	2	0.01
530-550M	17	0.13	1.33-1.35B	4	0.03	2.13-2.15B	3	0.02	2.93-2.95B	1	0.01
550-570M	12	0.09	1.35-1.37B	4	0.03	2.15-2.17B	1	0.01	2.95-2.97B	0	0
570-590M	17	0.13	1.37-1.39B	4	0.03	2.17-2.19B	0	0	2.97-2.99B	1	0.01
590-610M	13	0.1	1.39-1.41B	4	0.03	2.19-2.21B	1	0.01	>2.99B	148	1.1
610-630M	10	0.07	1.41-1.43B	3	0.02	2.21-2.23B	1	0.01			
630-650M	14	0.1	1.43-1.45B	3	0.02	2.23-2.25B	2	0.01			
650-670M	8	0.06	1.45-1.47B	2	0.01	2.25-2.27B	1	0.01			
670-690M	11	0.08	1.47-1.49B	2	0.01	2.27-2.29B	1	0.01			
690-710M	7	0.05	1.49-1.51B	2	0.01	2.29-2.31B	3	0.02			
710-730M	11	0.08	1.51-1.53B	4	0.03	2.31-2.33B	1	0.01			
730-750M	2	0.01	1.53-1.55B	4	0.03	2.33-2.35B	1	0.01			
750-770M	6	0.04	1.55-1.57B	2	0.01	2.35-2.37B	1	0.01			
770-790M	5	0.04	1.57-1.59B	4	0.03	2.37-2.39B	1	0.01			

PANEL B. DISTRIBUTION OF ALL BANKS BASED ON SIZE IN THE FIRST QUARTER OF 1997

Size	Freq	Percent	Size	Freq	Percent	Size	Freq	Percent	Size	Freq	Percent
<10M	236	2.51	790-810M	17	0.18	1.59-1.61B	2	0.02	2.39-2.41B	0	0
10-30M	1778	18.88	810-830M	9	0.1	1.61-1.63B	1	0.01	2.41-2.43B	1	0.01
30-50M	1724	18.31	830-850M	11	0.12	1.63-1.65B	2	0.02	2.43-2.45B	2	0.02
50-70M	1195	12.69	850-870M	12	0.13	1.65-1.67B	3	0.03	2.45-2.47B	0	0
70-90M	854	9.07	870-890M	8	0.08	1.67-1.69B	2	0.02	2.47-2.49B	1	0.01
90-110M	634	6.73	890-910M	5	0.05	1.69-1.71B	2	0.02	2.49-2.51B	3	0.03
110-130M	472	5.01	910-930M	5	0.05	1.71-1.73B	3	0.03	2.51-2.53B	2	0.02
130-150M	353	3.75	930-950M	8	0.08	1.73-1.75B	5	0.05	2.53-2.55B	2	0.02
150-170M	246	2.61	950-970M	4	0.04	1.75-1.77B	1	0.01	2.55-2.57B	1	0.01
170-190M	208	2.21	970-990M	2	0.02	1.77-1.79B	1	0.01	2.57-2.59B	0	0
190-210M	157	1.67	990-1010M	2	0.02	1.79-1.81B	2	0.02	2.59-2.61B	1	0.01
210-230M	140	1.49	1.01-1.03B	9	0.1	1.81-1.83B	0	0	2.61-2.63B	1	0.01
230-250M	124	1.32	1.03-1.05B	2	0.02	1.83-1.85B	3	0.03	2.63-2.65B	1	0.01
250-270M	107	1.14	1.05-1.07B	4	0.04	1.85-1.87B	0	0	2.65-2.67B	0	0
270-290M	75	0.8	1.07-1.09B	11	0.12	1.87-1.89B	3	0.03	2.67-2.69B	2	0.02
290-310M	57	0.61	1.09-1.11B	8	0.08	1.89-1.91B	0	0	2.69-2.71B	0	0
310-330M	62	0.66	1.11-1.13B	5	0.05	1.91-1.93B	2	0.02	2.71-2.73B	3	0.03
330-350M	55	0.58	1.13-1.15B	5	0.05	1.93-1.95B	1	0.01	2.73-2.75B	1	0.01
350-370M	37	0.39	1.15-1.17B	5	0.05	1.95-1.97B	0	0	2.75-2.77B	1	0.01
370-390M	42	0.45	1.17-1.19B	6	0.06	1.97-1.99B	0	0	2.77-2.79B	3	0.03
390-410M	28	0.3	1.19-1.21B	7	0.07	1.99-2.01B	1	0.01	2.79-2.81B	1	0.01
410-430M	31	0.33	1.21-1.23B	3	0.03	2.01-2.03B	3	0.03	2.81-2.83B	0	0
430-450M	44	0.47	1.23-1.25B	6	0.06	2.03-2.05B	3	0.03	2.83-2.85B	0	0
450-470M	25	0.27	1.25-1.27B	5	0.05	2.05-2.07B	0	0	2.85-2.87B	0	0
470-490M	35	0.37	1.27-1.29B	2	0.02	2.07-2.09B	1	0.01	2.87-2.89B	0	0
490-510M	23	0.24	1.29-1.31B	2	0.02	2.09-2.11B	0	0	2.89-2.91B	0	0
510-530M	29	0.31	1.31-1.33B	2	0.02	2.11-2.13B	4	0.04	2.91-2.93B	1	0.01
530-550M	31	0.33	1.33-1.35B	8	0.08	2.13-2.15B	2	0.02	2.93-2.95B	1	0.01
550-570M	17	0.18	1.35-1.37B	4	0.04	2.15-2.17B	3	0.03	2.95-2.97B	0	0
570-590M	12	0.13	1.37-1.39B	2	0.02	2.17-2.19B	3	0.03	2.97-2.99B	3	0.03
590-610M	20	0.21	1.39-1.41B	3	0.03	2.19-2.21B	1	0.01	>2.99B	190	2.02
610-630M	12	0.13	1.41-1.43B	5	0.05	2.21-2.23B	2	0.02			
630-650M	9	0.1	1.43-1.45B	3	0.03	2.23-2.25B	2	0.02			
650-670M	11	0.12	1.45-1.47B	1	0.01	2.25-2.27B	0	0			
670-690M	11	0.12	1.47-1.49B	0	0	2.27-2.29B	1	0.01			
690-710M	2	0.02	1.49-1.51B	3	0.03	2.29-2.31B	0	0			
710-730M	6	0.06	1.51-1.53B	4	0.04	2.31-2.33B	1	0.01			
730-750M	6	0.06	1.53-1.55B	1	0.01	2.33-2.35B	0	0			
750-770M	13	0.14	1.55-1.57B	2	0.02	2.35-2.37B	2	0.02			
770-790M	11	0.12	1.57-1.59B	2	0.02	2.37-2.39B	0	0			

TABLE 3 CONSUMER PRICE INDEX AND PRODUCER PRICE INDEX

This table contains the consumer price index (Panel A) and producer price index (Panel B) for each quarter of 1988 to 1997.

PANEL A. CONSUMER PRICE INDEX AND PERCENTAGE CHANGE

Year	Quarter	Value	Annual Average	Yearly Percent Change
1988	1	116.6		
1988	2	118.1		
1988	3	119.6		
1988	4	120.8	118.4	4.1
1989	1	122.3		
1989	2	124.1		
1989	3	124.9		
1989	4	126.4	124	4.8
1990	1	128.6		
1990	2	130		
1990	3	132.6		
1990	4	134.3	130.8	5.4
1991	1	134.9		
1991	2	136.1		
1991	3	137.1		
1991	4	138.3	136.3	4.2
1992	1	139.2		
1992	2	140.2		
1992	3	141.2		
1992	4	142.4	140.4	3
1993	1	143.4		
1993	2	144.4		
1993	3	145.1		
1993	4	146.4	144.6	3
1994	1	147.2		
1994	2	148		
1994	3	149.4		
1994	4	150.2	148.3	2.6
1995	1	151.3		
1995	2	152.5		
1995	3	153.2		
1995	4	154.1	152.5	2.8
1996	1	155.6		
1996	2	156.8		
1996	3	157.8		
1996	4	159.2	157	2.9
1997	1	159.9		
1997	2	160.3		
1997	3	161.3		
1997	4	161.9	160.6	2.3

Source: Federal Reserve of Dallas

PANEL B. PRODUCER PRICE INDEX AND PERCENTAGE CHANGE

Year	Month	Value	Annual Average	Year-over-Year Percent Change
1988	1	106.6		
1988	2	107.5		
1988	3	109		
1988	4	110	108	2.5
1989	1	112.3		
1989	2	114		
1989	3	114		
1989	4	115.5	113.5	5.1
1990	1	117.5		
1990	2	117.6		
1990	3	120.7		
1990	4	122	119.1	4.9
1991	1	121.4		
1991	2	121.4		
1991	3	121.5		
1991	4	122.1	121.7	2.2
1992	1	122.4		
1992	2	123.4		
1992	3	123.7		
1992	4	124.2	123.2	1.2
1993	1	125		
1993	2	125.2		
1993	3	124.1		
1993	4	124.4	124.7	1.2
1994	1	125.1		
1994	2	125.2		
1994	3	125.9		
1994	4	126.6	125.5	0.6
1995	1	127.4		
1995	2	127.8		
1995	3	128.1		
1995	4	129.3	127.9	1.9
1996	1	130.5		
1996	2	131.3		
1996	3	131.8		
1996	4	132.8	131.3	2.6
1997	1	132.6		
1997	2	131.3		
1997	3	131.8		
1997	4	131.2	131.8	0.4

Source: Federal Reserve of Dallas

TABLE 4. QUARTILE CRITERIA BOUNDARIES FOR BANK SIZE

Quartile criteria are applied to classify the bank size. *Q1*, *Q2*, and *Q3* are the cutoffs of the bank size in total assets.

		Quartile Boundary		
Year	Quarter	*Q1(x1,000)*	*Q2(x1,000)*	*Q3(x1,000)*
1988	q1	20045	39700	82256
	q2	20268	40030	83851
	q3	20490	40334	84249
	q4	21024	41291	86371
1989	q1	21249	41597	86866
	q2	21332	41822	88376
	q3	21565	42324	90434
	q4	22090	43900	93702
1990	q1	22495	44462	94207
	q2	22861	45046	96538
	q3	23078	45581	98354
	q4	23746	46936	100406
1991	q1	24039	47281	100492
	q2	24401	47676	101718
	q3	24877	48373	103620
	q4	25578	49125	104925
1992	q1	25999	50089	106683
	q2	26124	50640	107319
	q3	26640	51456	108507
	q4	27291	52979	110950
1993	q1	27542	52925	110143
	q2	27788	53515	110752
	q3	28179	54688	112788
	q4	28951	55743	115101
1994	q1	29066	55995	116303
	q2	29210	56222	116829
	q3	29566	57132	119454
	q4	30093	58210	121334
1995	q1	29925	58192	121375
	q2	30566	59706	124625
	q3	31043	61016	126872
	q4	32073	62796	130256
1996	q1	32213	63200	131231
	q2	32157	63317	131421
	q3	32546	64745	133979
	q4	33326	65896	137337
1997	q1	33237	65954	138596
	q2	33604	66052	138728
	q3	33968	66626	139240
	q4	34449	68231	142863

TABLE 5. NUMBER OF COMMERCIAL BANKS IN DIFFERENT SIZE, AGRICULTURAL, AND MSA CATEGORIES IN THE UNITED STATES

L: Large banks with total assets not less than $300 million. M: Medium banks with total assets between $300 and $100 million. S: Small banks with total assets below $100 million. A: Agricultural banks with agricultural loan ratio not less than 25 percent of total assets. NA: Non-agricultural banks with agricultural loan ratio less than 25 percent of total assets. M' & NM': Banks chartered in MSA and non-MSA respectively

Qt/Yr	LAM'	LANM'	LNAM'	LNANM'	MAM'	MANM'	MNAM'	MNANM'	SAM'	SANM'	SNAM'	SNANM'
01/88	1	0	839	55	3	25	1214	595	167	2023	4006	4565
02/88	0	0	849	53	5	27	1225	612	177	2132	3882	4400
03/88	0	0	854	55	4	29	1207	621	175	2130	3796	4317
04/88	0	0	872	58	3	36	1221	639	166	1993	3703	4380
01/89	0	0	851	57	2	28	1217	659	153	1904	3673	4407
02/89	0	0	869	58	2	29	1229	672	166	2022	3625	4229
03/89	0	0	884	62	5	34	1231	679	169	2064	3531	4119
04/89	0	0	898	67	5	38	1261	713	157	1960	3449	4110
01/90	0	0	902	68	4	36	1243	728	145	1881	3418	4122
02/90	1	0	903	71	3	40	1249	735	159	1986	3337	3972
03/90	0	0	910	76	3	43	1256	744	164	2006	3272	3888
04/90	1	1	925	80	7	44	1257	772	157	1920	3227	3907
01/91	1	0	913	80	7	43	1251	774	153	1872	3196	3915
02/91	1	0	925	84	7	49	1234	777	161	1986	3137	3747
03/91	1	1	922	90	8	57	1237	788	161	2017	3076	3667
04/91	1	1	926	91	7	61	1228	806	159	1911	2978	3703
01/92	1	1	925	92	7	64	1239	816	141	1840	2925	3708
02/92	1	0	918	93	6	64	1231	817	159	1947	2848	3554
03/92	1	1	921	94	7	69	1243	818	159	1943	2793	3496
04/92	1	1	930	98	8	69	1261	803	170	1774	2895	3414
01/93	1	1	909	101	7	62	1232	802	156	1688	2873	3458
02/93	1	1	899	101	10	67	1233	796	155	1770	2798	3330
03/93	1	1	906	107	9	73	1254	796	164	1812	2689	3235
04/93	1	1	910	112	9	72	1246	814	156	1738	2608	3266
01/94	1	1	914	113	8	67	1227	832	136	1656	2573	3288
02/94	1	0	907	118	8	75	1214	832	151	1742	2498	3148
03/94	1	0	916	118	11	82	1221	828	149	1757	2412	3071
04/94	1	0	918	121	10	74	1219	845	142	1603	2358	3133
01/95	1	0	897	124	7	70	1194	822	130	1532	2309	3126
02/95	2	1	923	123	7	82	1214	826	130	1584	2257	2993
03/95	4	2	940	128	10	85	1207	844	135	1597	2169	2904
04/95	3	2	945	131	7	86	1241	864	121	1476	2117	2921
01/96	3	1	948	136	7	70	1217	870	109	1398	2092	2956
02/96	4	1	908	134	11	86	1217	855	122	1456	2021	2845
03/96	3	1	914	142	10	82	1223	872	114	1452	1967	2776
04/96	3	1	938	143	9	81	1238	906	105	1371	1927	2776
01/97	2	1	937	147	5	72	1218	919	90	1269	1925	2832
02/97	3	4	887	147	9	77	1226	902	101	1339	1862	2709
03/97	3	5	874	158	8	82	1213	887	98	1348	1857	2644
04/97	3	5	881	169	7	89	1217	912	93	1282	1822	2621

TABLE 6. THE NUMBER, MEAN, AND STANDARD DEVIATION OF X-EFFICIENCY OF ALL COMMERCIAL BANKS IN DIFFERENT CATEGORIES

This table contains average X-efficiency of all commercial banks sorted by various characteristics. The X-efficiency is calculated using quarterly data from 1988 – 1997 using the translog cost function and estimated using the distribution free approach of Berger (1993). L: Large banks with total assets not less than $300 million. M: Medium banks with total assets between $300 and $100 million. S: Small banks with total assets below $100 million. A: Agricultural banks with agricultural loan ratio not less than 25 percent of total assets. NA: Non-agricultural banks with agricultural loan ratio less than 25 percent of total assets. M' & NM': Banks chartered in MSA and non-MSA respectively.

Banks sorted based on size	N	Mean	STD
L	1947	0.9652	0.015
M	4580	0.9625	0.0145
S	12141	0.9624	0.0126
Banks sorted based on specialties			
A	3071	0.9611	0.0128
NA	13493	0.9627	0.0126
Banks sorted based on charter location			
M'	7703	0.9633	0.0133
NM'	7675	0.9618	0.0118
Interaction of size, specialties, and charter location			
LAM'	5	0.9614	0.015
LANM'	7	0.9549	0.0052
LNAM'	1712	0.9655	0.0152
LNANM'	267	0.9637	0.0157
MAM'	24	0.9584	0.0144
MANM'	172	0.9637	0.0148
MNAM'	2928	0.9622	0.0151
MNANM'	1665	0.9629	0.0141
SAM'	320	0.9603	0.0149
SANM'	2733	0.9611	0.0127
SNAM'	5377	0.9629	0.0136
SNANM'	5612	0.9617	0.0122

TABLE 7. PAIRWISE COMPARISON OF X-EFFICIENCY MEANS BASED ON SIZE, LOAN SPECIALTIES, AND CHARTER LOCATION OF THE COMMERCIAL BANKS IN THE UNITED STATES

The following table contains pairwise comparisons of X-efficiencies across different categories of banks. L: large size commercial banks, M: medium size, S: small size commercial banks, A: agricultural commercial banks (agricultural loans ratio are greater than 25% of total assets), M': metropolitan statistical area (MSA), and N: non. For example, MNANM represents medium non-agricultural commercial banks in non-MSA.

Comparason of Samples	t Value	Relationship of the Comparison
Banks sorted based on size		
L – M	6.62***	
L – S	7.8***	L > M=S
M - S	0.57	
Banks sorted based on loan specialties		
A - NA	-6.45***	A < NA
Banks sorted based on charter location		
M' – NM'	7.65***	M' > NM'
Interaction of size, specialties, and charter location		
LAM' – LANM'	0.92	LAM' = LANM'
LAM' – LNAM'	-0.62	LAM' = LNAM'
LAM' – LNANM'	-0.36	LAM' = LNANM'
LANM' – LNAM'	-5.35***	LANM' < LNAM'
LANM' – LNANM'	-4.1***	LANM' < LNANM'
LNAM' – LNANM'	1.85*	LNAM' > LNANM'
MAM' – MANM'	-1.64	MAM' = MANM'
MAM' – MNAM'	-1.23	MAM' = MNAM'
MAM' – MNANM'	-1.62	MAM' = MNANM'
MANM' – MNAM'	1.25	MANM' = MNAM'
MANM' – MNANM'	0.68	MANM' = MNANM'
MNAM' – MNANM'	-1.69*	MNAM' < MNANM'
SAM' – SANM'	-0.97	SAM' = SANM'
SAM' – SNAM'	-3.08***	SAM' < SNAM'
SAM' – SNANM'	-1.66*	SAM' < SNANM'
SANM' – SNAM'	-5.86***	SANM' < SNAM'
SANM' – SNANM'	-1.95*	SANM' < SNANM'
SNAM' – SNANM'	4.93***	SNAM' > SNANM'

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively. Values are for the statistics using the Cochran and Cox approximation.

TABLE 8. PAIRWISE COMPARISON OF X-EFFICIENCY MEANS BASED ON BANK SIZE IN DIFFERENT CATEGORIES

The following table contains the results of pairwise comparison of x-efficiency based on bank size.

L: large size commercial banks, M: medium size, S: small size commercial banks, A: agricultural commercial banks (agricultural loans ratio are greater than 25% of total assets), M': metropolitan statistical area (MSA), and N: non. For example, MNANM represents medium non-agricultural commercial banks in non-MSA.

Bank Size	A - NA	Relationship
L	-7.83***	NA>A
M	3.35***	A>NA
S	2.49**	A>NA

Bank Size	M' - NM'	Relationship
L	4.40***	M'>NM'
M	-5.82***	NM'>M'
S	8.23***	M'>NM'

TABLE 9. PAIRWISE COMPARISON OF X-EFFICIENCY MEANS BASED ON LOAN SPECIALIZATION AND CHARTER LOCATION IN DIFFERENT CATEGORIES

The following table contains the results of pairwise comparison of x-efficiency based on loan specialization and charter location.

L: large size commercial banks, M: medium size, S: small size commercial banks, A: agricultural commercial banks (agricultural loans ratio are greater than 25%), M': metropolitan statistical area (MSA), and N: non. For example, MNANM represents medium non-agricultural commercial banks in non-MSA.

Loan Specialization	L - M	L - S	M - S	Relationship
A	-6.09***	-2.64***	5.63***	M>S>L
NA	16.12***	26.32***	13.16***	L>M>S

Charter Location	L - M	L - S	M - S	Relationship
M'	18.14***	16.30***	-2.22**	L>S>M
NM'	0.02	3.39***	11.01***	L=M>S

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively. Values are for the statistics using the Cochran and Cox approximation.

TABLE 10. COMPARISON OF BANK EFFICIENCY BASED ON LOAN SPECIALIZATION IN DETAILED SIZE CATEGORIES

This table contains the comparison of bank efficiency based on loan specialization by using the detailed size categories. Cochran statistics are used to test the difference between efficiencies of banks without agricultural loan specialization (NA) and banks with agricultural loan specialization (A). Because of the lack of observations of banks with agricultural loan specialization, the results of the banks with $600 million or higher in total assets are not available.

Size (total assets, million dollars)	t Value (NA-A)	Results
0-10	24.18***	NA>A
10-20	13.12***	NA>A
20-30	-19.62***	A>NA
30-40	-18.99***	A>NA
40-50	-24.59***	A>NA
50-60	-16.45***	A>NA
60-70	-16.63***	A>NA
70-80	-12.92***	A>NA
80-90	-8.27***	A>NA
90-100	-10.18***	A>NA
100-150	-9.7***	A>NA
150-200	-2.51**	A>NA
200-250	-3.11***	A>NA
250-300	1.29	NA=A
300-400	3.8***	NA>A
400-500	4.33***	NA>A
500-600	.	.
600-700	.	.
700-800	.	.
800-900	.	.
900-1000	.	.
1000-1500	.	.
1500-2000	.	.
2000-3000	.	.
3000-5000	.	.
5000-10000	.	.
>10000	.	.

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively. Values are for the statistics using the Cochran and Cox approximation.

TABLE 11. THE FUNDAMENTAL INFORMATION MODEL

This table contains results of the estimation of the fundamental information model for explaining banks' X-efficiencies. Size is the size of the bank, measured by total assets in logarithm term. Size^2 represents the size of the bank in squared. Size^3 shows the size of the bank in cubed. AAR is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets. Inter is an interaction term, testing the relationship between agricultural loans and bank's size. Bkcapita represents banks per capita in the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on the quarterly data of average agricultural loans over the 10-year examination period. q_j = dummy variables measuring seasonal effect. q1 represents first quarter, q2 represents second quarter, and q3 represents third quarter. XEFF_i is the average efficiency of each commercial bank over 1988-1997 periods.

$$XEFF_i = a + b_1 size_i + b_2 size^2{}_i + b_3 size^3{}_i + b_4 AAR_i + b_5 Inter_i + b_5 bkcapita_i$$
$$+ b_6 Agprice_i + \sum_{j=1}^{3} g_j q_j$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variable			
Intercept	1.07545***	2.62388***	1.07718***
Size	-0.02762***	-0.49307***	-0.02642***
size^2	0.00203***	0.04795***	0.00182***
size^3	-4.37E-05***	-0.00153***	-3.59E-05***
AAR	-0.10998***	-0.06214***	-0.23956***
Inter	0.01082***	0.00732***	0.02158***
Bkcapita	4.14366***	3.79562***	7.35801***
Agprice	-2.87701E-8***	-5.56486E-7***	-3.28334E-8***
q1	0.00194***	0.00207***	0.00194***
q2	0.00092125***	0.00092995***	0.00094170***
q3	0.00023268***	0.00028747*	0.00023137***
Adjusted R^2:	0.0341	0.086	0.0341

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively.

TABLE 12. CORRELATION OF ESTIMATES OF THE FUNDAMENTAL INFORMATION MODEL BASED ON ALL BANKS' OBSERVATIONS

This table contains the correlation coefficient matrix of basic model. Size is the size of the bank, measured by total assets in logarithm term. $Size^2$ represents the size of the bank in squared. $Size^3$ shows the size of the bank in cubed. AAR is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets. Inter is an interaction term, testing the relationship between agricultural loans and bank's size. Bkcapita represents banks per capita in the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on the quarterly data of average agricultural loans over the 10-year examination period. q_i = dummy variables measuring seasonal effect. q1 represents first quarter, q2 represents second quarter, and q3 represents third quarter.

Variable	Intercept	size	$Size^2$	$size^3$	AAR	Inter	Bkcapita	Agprice	q1	q2	q3
Intercept	1	-0.9992	0.9972	-0.9942	0.1333	-0.1311	-0.0253	0.0022	0.0047	0.0066	-0.0016
size	-0.9992	1	-0.9994	0.9976	-0.1394	0.137	0.0297	-0.0015	-0.0053	-0.0071	0.001
$size^2$	0.9972	-0.9994	1	-0.9994	0.142	-0.1394	-0.034	0.0009	0.0054	0.0069	-0.001
$size^3$	-0.9942	0.9976	-0.9994	1	-0.1418	0.139	0.0381	-0.0003	-0.0054	-0.0067	0.001
AAR	0.1333	-0.1394	0.142	-0.1418	1	-0.9983	-0.0455	0.0343	-0.0001	0.0001	-0.0019
Inter	-0.1311	0.137	-0.1394	0.139	-0.9983	1	0.014	-0.0458	0.0008	-0.0005	0.001
Bkcapita	-0.0253	0.0297	-0.034	0.0381	-0.0455	0.014	1	0.0383	-0.0067	0.0059	0.0079
Agprice	0.0022	-0.0015	0.0009	-0.0003	0.0343	-0.0458	0.0383	1	-0.0084	-0.0058	-0.0049
q1	0.0047	-0.0053	0.0054	-0.0054	-0.0001	0.0008	-0.0067	-0.0084	1	0.5308	0.5266
q2	0.0066	-0.0071	0.0069	-0.0067	0.0001	-0.0005	0.0059	-0.0058	0.5308	1	0.5233
q3	-0.0016	0.001	-0.001	0.001	-0.0019	0.001	0.0079	-0.0049	0.5266	0.5233	1

TABLE 13. CORRELATION OF ESTIMATES OF THE FUNDAMENTAL INFORMATION MODEL BASED ON BANKS' OBSERVATIONS WITH AGRICULTURAL LOAN SPECIALIZATION

This table contains the correlation coefficient matrix of basic model. Size is the size of the bank, measured by total assets in logarithm term. $Size^2$ represents the size of the bank in squared. $Size^3$ shows the size of the bank in cubed. AAR is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets. Inter is an interaction term, testing the relationship between agricultural loans and bank's size. Bkcapita represents banks per capita in the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on the quarterly data of average agricultural loans over the 10-year examination period. q_i = dummy variables measuring seasonal effect. q1 represents first quarter, q2 represents second quarter, and q3 represents third quarter.

Variable	Intercept	size	$Size^2$	$size^3$	AAR	Inter	Bkcapita	Agprice	q1	q2	q3
Intercept	1	-0.9966	0.9888	-0.9791	-0.0761	0.0741	0.0139	0.1499	-0.0048	-0.0043	-0.0037
size	-0.9966	1	-0.9977	0.9921	0.0169	-0.0148	-0.0167	-0.1766	0.0032	0.0031	0.0023
$size^2$	0.9888	-0.9977	1	-0.9983	0.0225	-0.025	0.0169	0.2025	-0.0038	-0.0038	-0.0028
$size^3$	-0.9791	0.9921	-0.9983	1	-0.0424	0.0453	-0.0159	-0.228	0.0045	0.0045	0.0033
AAR	-0.0761	0.0169	0.0225	-0.0424	1	-0.9972	-0.0117	0.1635	-0.0042	-0.0116	-0.0106
Inter	0.0741	-0.0148	-0.025	0.0453	-0.9972	1	-0.0065	-0.18	0.0062	0.0125	0.0106
Bkcapita	0.0139	-0.0167	0.0169	-0.0159	-0.0117	-0.0065	1	0.0303	-0.0101	0.0067	0.0132
Agprice	0.1499	-0.1766	0.2025	-0.228	0.1635	-0.18	0.0303	1	-0.0209	-0.0162	-0.0104
q1	-0.0048	0.0032	-0.0038	0.0045	-0.0042	0.0062	-0.0101	-0.0209	1	0.5052	0.5061
q2	-0.0043	0.0031	-0.0038	0.0045	-0.0116	0.0125	0.0067	-0.0162	0.5052	1	0.5134
q3	-0.0037	0.0023	-0.0028	0.0033	-0.0106	0.0106	0.0132	-0.0104	0.5061	0.5134	1

TABLE 14. CORRELATION OF ESTIMATES OF THE FUNDAMENTAL INFORMATION MODEL BASED ON BANKS' OBSERVATIONS WITHOUT AGRICULTURAL LOAN SPECIALIZATION

It is the correlation coefficient matrix of basic model. **size** is the size of the bank, measured by total assets in logarithm term. **size2** represents the size of the bank in square term, measuring the square effect of the bank size. **size3** shows the size of the bank in cube term. **AAR** is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets. **Inter** is interaction term, testing the relationship between agricultural and bank's size. **Bkcapita** represents banks per capita in the county level, which is the proxy of the competitiveness of the local financial market. It is the ratio of number of commercial banks chartered in the county to the population of the county. **Agprice** shows the volatility of agricultural loans based on the quarterly data of average agricultural loans over 10-year examination period. **qj** = dummy variables measuring seasonal effect. **q1** represents first quarter, **q2** represents second quarter, and **q3** represents third quarter.

Variable	Intercept	size	Siz2	siz3	AAR	Inter	Bkcapita	Agprice	q1	q2	q3
Intercept	1	-0.9964	0.986	-0.9693	-0.2132	0.2156	-0.0144	0.179	-0.0089	-0.0087	-0.0082
size	-0.9964	1	-0.9966	0.9863	0.1736	-0.176	-0.0009	-0.2071	0.0019	0.0018	0.0015
size2	0.986	-0.9966	1	-0.9965	-0.1356	0.1378	0.0103	0.2379	-0.0015	-0.0014	-0.0012
size3	-0.9693	0.9863	-0.9965	1	0.1014	-0.1032	-0.0163	-0.2719	0.0012	0.001	0.001
AAR	-0.2132	0.1736	-0.1356	0.1014	1	-0.9954	-0.1321	0.172	-0.0038	-0.0008	-0.0001
Inter	0.2156	-0.176	0.1378	-0.1032	-0.9954	1	0.0845	-0.1815	0.0045	0.0005	-0.0004
Bkcapita	-0.0144	-0.0009	0.0103	-0.0163	-0.1321	0.0845	1	0.0039	-0.0071	0.0024	0.0055
Agprice	0.179	-0.2071	0.2379	-0.2719	0.172	-0.1815	0.0039	1	-0.0034	-0.0004	0.0006
q1	-0.0089	0.0019	-0.0015	0.0012	-0.0038	0.0045	-0.0071	-0.0034	1	0.5063	0.5044
q2	-0.0087	0.0018	-0.0014	0.001	-0.0008	0.0005	0.0024	-0.0004	0.5063	1	0.5018
q3	-0.0082	0.0015	-0.0012	0.001	-0.0001	-0.0004	0.0055	0.0006	0.5044	0.5018	1

TABLE 15. AGRICULTURAL PRODUCTS CATEGORIES

This table contains relative weights of commodities in the indexes of prices received by farmers, base weight period 1990-92, from the USDA Statistical Bulletin.

Commodity and Group	Relative Weight (percent)	Commodity and Group	Relative Weight (percent)
Wheat	4.0	Onions	0.5
Rice	0.7	Sweet Corn	0.4
Food Grains	4.7	Tomatoes	1.6
		Broccoli	0.2
Corn	8.3	Cantaloupes	0.2
Oats	0.1	Cauliflower	0.2
Barley	0.5	Cucumbers	0.3
Grain Sorghum	0.7	Snap Beans	0.3
All Hay	1.8	**Commercial Vegetables**	5.1
Feed Grains and Hay	11.4		
American Upland Cotton	2.8	Dry Edible Beans	0.3
		Potatoes	1.3
		Potatoes and Dry Beans	1.6
Tobacco	1.7		
Cottonseed	0.3	**Other Crops**	7.5
Peanuts	0.8		
Soybeans	6.5	All Crops	48.4
Sunflower	0.2		
Oil-Bearing Crops	7.8	Beef Cattle	22
		Calves	1.9
Apples	1.2	Hogs	6.7
Grapefruit	0.3	**Meat Animals**	30.6
Lemons	0.2		
Oranges	1.2	Milk, Wholesale	11.7
Peaches	0.3	Dairy Products	11.7
Pears	0.2		
Strawberries	0.5	Eggs	2.4
Grapes	1.4	Broilers	5.4
Almonds	0.5	Turkeys	1.5
Fruit and Nuts	5.8	**Poultry and Eggs**	9.3
Asparagus	0.1	Livestock and	
Carrots	0.3	Products	51.6
Celery	0.2		
Lettuce	0.8	All Farm Products	100

TABLE 16. LOCAL ECONOMIC ACTIVITY EFFECT MODEL

This table contains the results of the estimation of the relationship between bank's X-efficiency and bank's fundamental information and agricultural factors effects. Size is the size of the bank, measured by total assets in logarithm term. Size^2 represents the size of the bank in squared. Size^3 shows the size of the bank in cubed. AAR is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets of the bank. Inter is interaction term, testing the relationship between agricultural loans and bank's size. Bkcapita represents banks per capita at the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on quarterly data of average agricultural loans over 10-year examination period. AgR is agricultural products ratio. Thus, AgR*AAR represents the agricultural loans on specified agricultural products at the county level. XEFFi is the quarterly average efficiency of each commercial bank over 1988-1992 periods.

$$XEFF_i = \boldsymbol{a} + \boldsymbol{b}_1 size_i + \boldsymbol{b}_2 size^2{}_i + \boldsymbol{b}_3 size^3{}_i + \boldsymbol{b}_4 AAR_i + \boldsymbol{b}_5 Inter_i + \boldsymbol{b}_5 bkcapita_i + \boldsymbol{b}_6 Agprice_i + \sum_{j=1}^{10} \boldsymbol{r}_j (AgR_{ji} * AAR_i)$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variables			
Intercept	1.1254***	2.8542***	1.10323***
size	-0.04557***	-0.56022***	-0.03798***
size^2	0.00376***	0.05414***	0.00299***
size^3	-0.00009436***	-0.00172***	-7.04E-05***
AAR	-0.18112***	-0.13063***	-0.35185***
Inter	0.01539***	0.01296***	0.02816***
Bkcapita	5.14***	5.2596***	8.73733***
Agprice	-4.06E-09	-7.44E-07***	-1.51E-08
Food Grains	0.02097***	0.00393	0.01545
Feed Grains and Hay	0.05672***	0.03788***	0.0949***
Cotton	-0.00366	-0.00727	-0.02654**
Tobacco	0.05435***	0.15327***	0.06661***
Oil-Bearing Crop	0.04338***	0.03074***	0.10568***
Fruit and Nuts	-0.04548***	-0.04207**	-0.01785
Vegetable	-0.06797***	-0.09699***	0.00788
Meat Animals	0.02448***	0.00968***	0.03***
Diary Products	0.06294***	0.06367***	0.0917***
Poultry and Egg	0.01954***	-0.0009893	0.05364***
Adj R-Sq	0.1197	0.2123	0.1137

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively.

TABLE 17. CORRELATION OF ESTIMATES OF LOCAL ECONOMIC ACTIVITY EFFECT MODEL BASED ON ALL BANKS' OBSERVATIONS

This table contains the correlation coefficient matrix of agricultural effect model. **size** is the size of the bank. **size^2** represents the size of the bank in square term. **size^3** shows the size of the bank in cube term. **AAR** is the average agricultural loan ratio. **Inter** is interaction term, testing the relationship between agricultural and bank's size. **Bkcapita** represents banks per capita in the county level. **Agprice** shows the volatility of agricultural loans. **Ag1, Ag2, Ag3, Ag4, Ag5, Ag6, Ag7, Ag8, Ag9 and Ag10** are food grains, feed grains and hay, cotton, tobacco, oil-bearing crop, fruit and nuts, vegetable, meat animals, diary products, and poultry and egg.

Variable	Intercept	size	size^2	size^3	AAR	Inter	Bkcapita	Agprice	Ag1	Ag2	Ag3	Ag4	Ag5	Ag6	Ag7	Ag8	Ag9	Ag10
Intercept	1	-0.997	0.9883	-0.9741	-0.3349	0.3783	-0.0126	0.2499	0.0085	0.0072	-0.0075	0.0086	0.0075	-0.0082	-0.0105	0.0021	0.0039	0.0042
size	-0.997	1	-0.9971	0.9884	0.3015	-0.3417	0	-0.2756	-0.0055	-0.0037	0.0077	-0.0093	-0.0086	0.0083	0.0094	0.0006	-0.0058	-0.0042
size^2	0.9883	-0.9971	1	-0.997	-0.2682	0.3046	0.0081	0.3033	0.0037	0.0013	-0.0075	0.0094	0.0096	-0.0087	-0.0088	-0.0021	0.0072	0.0039
size^3	-0.9741	0.9884	-0.997	1	0.2362	-0.2685	-0.0133	-0.3335	-0.0026	0.0003	0.0071	-0.009	-0.0105	0.0091	0.0084	0.0028	-0.0082	-0.0036
AAR	-0.3349	0.3015	-0.2682	0.2362	1	-0.9007	-0.0117	0.083	-0.4326	-0.3763	-0.3028	-0.0984	-0.2783	-0.1124	-0.1194	-0.4605	-0.2931	-0.256
Inter	0.3783	-0.3417	0.3046	-0.2685	-0.9007	1	0.0093	-0.1184	0.0764	0.1017	-0.0122	0.005	0.015	-0.0041	-0.0167	0.0551	0.0093	0.0384
Bkcapita	-0.0126	0	0.0081	-0.0133	-0.0117	0.0093	1	0.0046	-0.1435	-0.1085	-0.0244	-0.0373	-0.0321	0.0332	0.0428	-0.1137	-0.0137	-0.0299
Agprice	0.2499	-0.2756	0.3033	-0.3335	0.083	-0.1184	0.0046	1	0.0221	0.0149	0.0179	0.0062	0.0241	-0.0081	-0.0037	0.0287	0.0199	0.0127
Ag1	0.0085	-0.0055	0.0037	-0.0026	-0.4326	0.0764	-0.1435	0.0221	1	0.5378	0.5989	0.2005	0.581	0.2187	0.2689	0.774	0.5536	0.4489
Ag2	0.0072	-0.0037	0.0013	0.0003	-0.3763	0.1017	-0.1085	0.0149	0.5378	1	0.5023	0.1566	-0.044	0.179	0.1577	0.5434	0.4018	0.3575
Ag3	-0.0075	0.0077	-0.0075	0.0071	-0.3028	-0.0122	-0.0244	0.0179	0.5989	0.5023	1	0.1638	0.4023	0.1929	0.183	0.684	0.4976	0.3801
Ag4	0.0086	-0.0093	0.0094	-0.009	-0.0984	0.005	-0.0373	0.0062	0.2005	0.1566	0.1638	1	0.1424	0.0649	0.0545	0.2153	0.1228	0.1118
Ag5	0.0075	-0.0086	0.0096	-0.0105	-0.2783	0.015	-0.0321	0.0241	0.581	-0.044	0.4023	0.1424	1	0.175	0.2002	0.6262	0.4277	0.2797
Ag6	-0.0082	0.0083	-0.0087	0.0091	-0.1124	-0.0041	0.0332	-0.0081	0.2187	0.179	0.1929	0.0649	0.175	1	-0.085	0.2535	0.1432	0.1358
Ag7	-0.0105	0.0094	-0.0088	0.0084	-0.1194	-0.0167	0.0428	-0.0037	0.2689	0.1577	0.183	0.0545	0.2002	-0.085	1	0.2895	0.1478	0.1389
Ag8	0.0021	0.0006	-0.0021	0.0028	-0.4605	0.0551	-0.1137	0.0287	0.774	0.5434	0.684	0.2153	0.6262	0.2535	0.2895	1	0.6022	0.4901
Ag9	0.0039	-0.0058	0.0072	-0.0082	-0.2931	0.0093	-0.0137	0.0199	0.5536	0.4018	0.4976	0.1228	0.4277	0.1432	0.1478	0.6022	1	0.2405
Ag10	0.0042	-0.0042	0.0039	-0.0036	-0.256	0.0384	-0.0299	0.0127	0.4489	0.3575	0.3801	0.1118	0.2797	0.1358	0.1389	0.4901	0.2405	1

TABLE 18. CORRELATION OF ESTIMATES OF LOCAL ECONOMIC ACTIVITY EFFECT MODEL BASED ON AGRICULTURAL BANKS' OBSERVATIONS

This table contains the correlation coefficient matrix of agricultural effect model. **size** is the size of the bank. **size^2** represents the size of the bank in square term. **size^3** shows the size of the bank in cube term. **AAR** is the average agricultural loan ratio. **Inter** is interaction term, testing the relationship between agricultural and bank's size. **Bkcapita** represents banks per capita in the county level. **Agprice** shows the volatility of agricultural loans. **Ag1, Ag2, Ag3, Ag4, Ag5, Ag6, Ag7, Ag8, Ag9 and Ag10** are food grains, feed grains and hay, cotton, tobacco, oil-bearing crop, fruit and nuts, vegetable, meat animals, diary products, and poultry and egg.

Variable	Intercept	size	size^2	size^3	AAR	Inter	Bkcapita	Agprice	Ag1	Ag2	Ag3	Ag4	Ag5	Ag6	Ag7	Ag8	Ag9	Ag10
Intercept	1	-0.9968	0.9894	-0.9801	-0.1406	0.141	0.0095	0.081	-0.0079	0.0107	0.0081	-0.2141	0.0067	-0.002	0.0084	-0.0141	0.0241	-0.0306
size	-0.9968	1	-0.9978	0.9925	0.0843	-0.0833	-0.0113	-0.1042	0.0042	-0.0132	-0.0138	0.2086	-0.0089	0.003	-0.0107	0.0077	-0.0269	0.0275
size^2	0.9894	-0.9978	1	-0.9984	-0.0461	0.0435	0.0108	0.1267	-0.001	0.0162	0.0186	-0.2026	0.0099	-0.0041	0.012	-0.0019	0.0288	-0.0252
size^3	-0.9801	0.9925	-0.9984	1	0.0259	-0.022	-0.0097	-0.1488	-0.0012	-0.019	-0.0225	0.1965	-0.0103	0.0049	-0.0127	-0.0028	-0.0305	0.0237
AAR	-0.1406	0.0843	-0.0461	0.0259	1	-0.9776	-0.0103	0.1474	-0.1157	-0.1361	-0.0776	0.0121	-0.0826	-0.0527	-0.0227	-0.106	-0.1013	-0.0502
Inter	0.141	-0.0833	0.0435	-0.022	-0.9776	1	0.0239	-0.1891	-0.0573	-0.0052	-0.0674	-0.0251	-0.0326	0.0153	-0.0276	-0.0888	-0.0076	-0.0391
Bkcapita	0.0095	-0.0113	0.0108	-0.0097	-0.0103	0.0239	1	0.0215	-0.1714	-0.1543	-0.0311	0.0046	0.0129	0.0446	0.0455	-0.146	0.0294	-0.0077
Agprice	0.081	-0.1042	0.1267	-0.1488	0.1474	-0.1891	0.0215	1	0.0947	0.0833	0.0848	0.0038	0.0989	-0.0166	0.0307	0.1252	0.104	0.0527
Ag1	-0.0079	0.0042	-0.001	-0.0012	-0.1157	-0.0573	-0.1714	0.0947	1	0.5871	0.6289	0.0655	0.5991	0.1723	0.2488	0.8094	0.496	0.4066
Ag2	0.0107	-0.0132	0.0162	-0.019	-0.1361	-0.0052	-0.1543	0.0833	0.5871	1	0.5243	0.0566	0.0137	0.1438	0.1449	0.5932	0.3708	0.3295
Ag3	0.0081	-0.0138	0.0186	-0.0225	-0.0776	-0.0674	-0.0311	0.0848	0.6289	0.5243	1	0.0518	0.4321	0.1534	0.161	0.7005	0.459	0.3437
Ag4	-0.2141	0.2086	-0.2026	0.1965	0.0121	-0.0251	0.0046	0.0038	0.0655	0.0566	0.0518	1	0.0415	0.0152	-0.0091	0.0724	0.0424	-0.0175
Ag5	0.0067	-0.0089	0.0099	-0.0103	-0.0826	-0.0326	0.0129	0.0989	0.5991	0.0137	0.4321	0.0415	1	0.1509	0.1764	0.6207	0.4002	0.2385
Ag6	-0.002	0.003	-0.0041	0.0049	-0.0527	0.0153	0.0446	-0.0166	0.1723	0.1438	0.1534	0.0152	0.1509	1	-0.1009	0.1945	0.0973	0.0892
Ag7	0.0084	-0.0107	0.012	-0.0127	-0.0227	-0.0276	0.0455	0.0307	0.2488	0.1449	0.161	-0.0091	0.1764	-0.1009	1	0.2542	0.1156	0.094
Ag8	-0.0141	0.0077	-0.0019	-0.0028	-0.106	-0.0888	-0.146	0.1252	0.8094	0.5932	0.7005	0.0724	0.6207	0.1945	0.2542	1	0.5276	0.4366
Ag9	0.0241	-0.0269	0.0288	-0.0305	-0.1013	-0.0076	0.0294	0.104	0.496	0.3708	0.459	0.0424	0.4002	0.0973	0.1156	0.5276	1	0.1499
Ag10	-0.0306	0.0275	-0.0252	0.0237	-0.0502	-0.0391	-0.0077	0.0527	0.4066	0.3295	0.3437	-0.0175	0.2385	0.0892	0.094	0.4366	0.1499	1

TABLE 19. CORRELATION OF ESTIMATES OF LOCAL ECONOMIC ACTIVITY EFFECT MODEL BASED ON NON-AGRICULTURAL BANKS' OBSERVATIONS

This Table contains the correlation coefficient matrix of agricultural effect model. **size** is the size of the bank. **size** ^{2} represents the size of the bank in square term. **size** ^{3} shows the size of the bank in cube term. **AAR** is the average agricultural loan ratio. **Inter** is interaction term, testing the relationship between agricultural and bank's size. **Bkcapita** represents banks per capita in the county level. **Agprice** shows the volatility of agricultural loans. **Ag1, Ag2, Ag3, Ag4, Ag5, Ag6, Ag7, Ag8, Ag9 and Ag10** are food grains, feed grains and hay, cotton, tobacco, oil-bearing crop, fruit and nuts, vegetable, meat animals, diary products, and poultry and egg.

Variable	Intercept	size	size^2	size^3	AAR	Inter	Bkcapita	Agprice	Ag1	Ag2	Ag3	Ag4	Ag5	Ag6	Ag7	Ag8	Ag9	Ag10
Intercept	1	-0.997	0.9883	-0.9745	-0.1765	0.1948	-0.0033	0.2688	-0.0192	-0.0056	-0.0021	0.0302	0.0116	-0.0099	-0.006	-0.0095	0.013	0.0153
size	-0.997	1	-0.9971	0.9887	0.141	-0.1569	-0.0091	-0.2965	0.022	0.0071	0.0028	-0.0293	-0.0096	0.0104	0.0057	0.0118	-0.0114	-0.0142
size^2	0.9883	-0.9971	1	-0.9972	-0.1079	0.121	0.0162	0.3255	-0.0237	-0.0079	-0.0033	0.0282	0.0081	-0.011	-0.0057	-0.013	0.0101	0.0131
size^3	-0.9745	0.9887	-0.9972	1	0.0786	-0.0891	-0.0202	-0.3561	0.0246	0.0084	0.0037	-0.027	-0.007	0.0116	0.0058	0.0135	-0.0089	-0.0119
AAR	-0.1765	0.141	-0.1079	0.0786	1	-0.9284	-0.0643	0.1468	-0.2704	-0.21	-0.2521	-0.1745	-0.2203	-0.1391	-0.1452	-0.3777	-0.3382	-0.2524
Inter	0.1948	-0.1569	0.121	-0.0891	-0.9284	1	0.0728	-0.1803	0.052	0.0274	0.0021	0.0195	0.0342	-0.0058	-0.0069	0.0529	0.0578	0.0159
Bkcapita	-0.0033	-0.0091	0.0162	-0.0202	-0.0643	0.0728	1	-0.002	-0.114	-0.0366	-0.0271	-0.0626	-0.0951	0.0203	0.0435	-0.1491	-0.0363	-0.0698
Agprice	0.2688	-0.2965	0.3255	-0.3561	0.1468	-0.1803	-0.002	1	0.0015	0.0139	0.0175	0.0211	0.0176	-0.0005	0.0026	0.0233	0.0203	0.0232
Ag1	-0.0192	0.022	-0.0237	0.0246	-0.2704	0.052	-0.114	0.0015	1	0.285	0.3762	0.2798	0.3122	0.2221	0.2539	0.4615	0.4848	0.4114
Ag2	-0.0056	0.0071	-0.0079	0.0084	-0.21	0.0274	-0.0366	0.0139	0.285	1	0.4311	0.2208	-0.369	0.2012	0.1186	0.3147	0.3207	0.3421
Ag3	-0.0021	0.0028	-0.0033	0.0037	-0.2521	0.0021	-0.0271	0.0175	0.3762	0.4311	1	0.2866	0.2257	0.2609	0.2179	0.5839	0.5296	0.4403
Ag4	0.0302	-0.0293	0.0282	-0.027	-0.1745	0.0195	-0.0626	0.0211	0.2798	0.2208	0.2866	1	0.2241	0.1713	0.1613	0.3688	0.299	0.2865
Ag5	0.0116	-0.0096	0.0081	-0.007	-0.2203	0.0342	-0.0951	0.0176	0.3122	-0.369	0.2257	0.2241	1	0.2022	0.2722	0.5197	0.4621	0.32
Ag6	-0.0099	0.0104	-0.011	0.0116	-0.1391	-0.0058	0.0203	-0.0005	0.2221	0.2012	0.2609	0.1713	0.2022	1	-0.0027	0.3407	0.2687	0.2534
Ag7	-0.006	0.0057	-0.0057	0.0058	-0.1452	-0.0069	0.0435	0.0026	0.2539	0.1186	0.2179	0.1613	0.2722	-0.0027	1	0.3537	0.2713	0.254
Ag8	-0.0095	0.0118	-0.013	0.0135	-0.3777	0.0529	-0.1491	0.0233	0.4615	0.3147	0.5839	0.3688	0.5197	0.3407	0.3537	1	0.6368	0.5587
Ag9	0.013	-0.0114	0.0101	-0.0089	-0.3382	0.0578	-0.0363	0.0203	0.4848	0.3207	0.5296	0.299	0.4621	0.2687	0.2713	0.6368	1	0.4376
Ag10	0.0153	-0.0142	0.0131	-0.0119	-0.2524	0.0159	-0.0698	0.0232	0.4114	0.3421	0.4403	0.2865	0.32	0.2534	0.254	0.5587	0.4376	1

TABLE 20. CHANGE OF LOCAL ECONOMIC EFFECT MODEL BASED ON X-EFFICIENCY CHANGE BETWEEN 1988 AND 1992

This table contains the results of the estimation of the relationship between the percentage change of bank's X-efficiency (1988-1992) and the percentage changes of bank's fundamental information and agricultural factors effects (1988-1992). ΔSize is the percentage change of bank's size, measured by total assets in logarithm term. ΔAAR is the percentage change of agricultural loan ratio, calculated from the average agricultural loans divided by the total assets of the bank. ΔInter is percentage change of interaction term, testing the relationship between agricultural loans and bank's size. ΔBkcapita represents the percentage change of banks per capita at the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on quarterly data of average agricultural loans over 10-year examination period. AgR is agricultural products ratio. Δ(AgR*AAR) represents the percentage change of agricultural loans on the specified agricultural products at the county level.

$$\Delta XEFF_i = a + b_1\Delta size_i + b_2\Delta AAR_i + b_3\Delta Inter_i + b_4\Delta bkcapita_i + b_5 Agprice_i + \sum_{j=1}^{10} r_j \Delta(AgR_{ji} * AAR_i)$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variables			
Intercept	-0.0039***	-0.00123***	-0.00493***
Δsize	0.00165***	0.00369***	0.00171***
ΔAAR	6.92E-05***	-6.57E-04	6.76E-05***
Δinter	-5.02E-05***	3.01E-07	-4.54E-05***
Δbkcapita	0.0006281	0.00015833	-0.00034287
agprice	1.17E-07***	-3.16E-07***	1.20E-07***
ΔFood Grains	9.61E-06	-0.03434*	0.00029646
ΔFeed Grains and Hay	-0.00059716*	-0.05046***	-0.00046287
ΔCotton	0.00074237	-0.03169**	0.00063059
ΔTobacco	-0.00054836*	0.32956***	-0.00060796**
ΔOil-Bearing Crop	0.00005784	-0.02236	-0.0001146
ΔFruit and Nuts	-0.00181***	-0.38629***	-0.0018***
ΔVegetable	-0.00063112*	0.12726**	-0.00065501*
ΔMeat Animals	-0.00004208	-0.01945*	-0.00009472
ΔDiary Products	-0.00010571	-0.13442***	-0.00013577
ΔPoultry and Eggs	-0.00040832	-0.02926***	-0.00032553
Adj R-Sq	0.0125	0.0183	0.0168

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively.

TABLE 21. CORRELATION OF ESTIMATES OF CHANGE OF LOCAL ECONOMIC ACTIVITY EFFECT MODEL BASED ON ALL BANKS' OBSERVATIONS BETWEEN 1988 AND 1992 PERIODS.

This table contains the correlation coefficient matrix of change of agricultural effect model based on all banks' observations. Δ represents percentage change of the specified variable. **size** is the size of the bank. **AAR** is the average agricultural loan ratio. **Inter** is interaction term, testing the relationship between agricultural and bank's size. **Bkcapita** represents banks per capita in the county level. **Agprice** shows the volatility of agricultural loans. **Ag1, Ag2, Ag3, Ag4, Ag5, Ag6, Ag7, Ag8, Ag9 and Ag10** are food grains, feed grains and hay, cotton, tobacco, oil-bearing crop, fruit and nuts, vegetable, meat animals, diary products, and poultry and egg.

Variable	Intercept	Δsize	ΔAAR	Δinter	Δbkcapita	agprice	ΔAg1	ΔAg2	ΔAg3	ΔAg4	ΔAg5	ΔAg6	ΔAg7	ΔAg8	ΔAg9	ΔAg10
Intercept	1	-0.4093	-0.0239	0.0185	0.3942	-0.1257	-0.0166	-0.0198	0.0153	0.0005	0.0145	0.0112	-0.0007	0.0151	-0.0088	-0.0239
Δsize	-0.4093	1	0.1927	-0.2062	0.0375	-0.074	-0.0009	-0.0252	-0.0104	0.0063	-0.0003	-0.0196	0.0262	0.0427	0.0219	0.0111
ΔAAR	-0.0239	0.1927	1	-0.9336	-0.015	-0.0985	0.047	-0.14	-0.06	-0.1109	-0.0824	-0.2023	-0.0032	0.1599	0.0577	0.0405
Δinter	0.0185	-0.2062	-0.9336	1	0.0267	0.0574	-0.041	0.028	0.0718	0.009	0.0395	0.1374	-0.1389	-0.1733	-0.1649	-0.0449
Δbkcapita	0.3942	0.0375	-0.015	0.0267	1	-0.0054	0.0167	0.0062	-0.0039	0.0004	-0.0166	0.0062	-0.0129	-0.0122	-0.0025	-0.0052
agprice	-0.1257	-0.074	-0.0985	0.0574	-0.0054	1	0.0295	0.1032	0.0019	0.064	0.0118	-0.063	-0.0213	-0.0083	0.1367	0.0647
ΔAg1	-0.0166	-0.0009	0.047	-0.041	0.0167	0.0295	1	0.3344	-0.2993	-0.1045	-0.4619	-0.0351	-0.0027	-0.2932	0.085	-0.1175
ΔAg2	-0.0198	-0.0252	-0.14	0.028	0.0062	0.1032	0.3344	1	-0.1542	-0.0868	-0.265	0.187	0.1669	-0.4788	0.3105	-0.1557
ΔAg3	0.0153	-0.0104	-0.06	0.0718	-0.0039	0.0019	-0.2993	-0.1542	1	0.0448	0.6278	0.0368	-0.0599	0.3065	-0.0614	0.0995
ΔAg4	0.0005	0.0063	-0.1109	0.009	0.0004	0.064	-0.1045	-0.0868	0.0448	1	0.1651	0.1414	0.2354	0.3189	0.403	0.0356
ΔAg5	0.0145	-0.0003	-0.0824	0.0395	-0.0166	0.0118	-0.4619	-0.265	0.6278	0.1651	1	0.0394	0.0575	0.4098	-0.0087	0.1481
ΔAg6	0.0112	-0.0196	-0.2023	0.1374	0.0062	-0.063	-0.0351	0.187	0.0368	0.1414	0.0394	1	0.5186	0.0811	0.0743	-0.0215
ΔAg7	-0.0007	0.0262	-0.0032	-0.1389	-0.0129	-0.0213	-0.0027	0.1669	-0.0599	0.2354	0.0575	0.5186	1	0.1478	0.2944	0.0626
ΔAg8	0.0151	0.0427	0.1599	-0.1733	-0.0122	-0.0083	-0.2932	-0.4788	0.3065	0.3189	0.4098	0.0811	0.1478	1	0.0549	0.2062
ΔAg9	-0.0088	0.0219	0.0577	-0.1649	-0.0025	0.1367	0.085	0.3105	-0.0614	0.403	-0.0087	0.0743	0.2944	0.0549	1	-0.1023
ΔAg10	-0.0239	0.0111	0.0405	-0.0449	-0.0052	0.0647	-0.1175	-0.1557	0.0995	0.0356	0.1481	-0.0215	0.0626	0.2062	-0.1023	1

TABLE 22. CORRELATION OF ESTIMATES OF CHANGE OF LOCAL ECONOMIC ACTIVITY EFFECT MODEL BASED ON AGRICULTURAL BANKS' OBSERVATIONS BETWEEN 1988 AND 1992 PERIODS.

This table contains the correlation coefficient matrix of change of agricultural effect model based on agricultural banks' observations. Δ represents percentage change of the specified variable. **size** is the size of the bank. **AAR** is the average agricultural loan ratio. **Inter** is interaction term, testing the relationship between agricultural and bank's size. **Bkcapita** represents banks per capita in the county level. **Agprice** shows the volatility of agricultural loans. **Ag1, Ag2, Ag3, Ag4, Ag5, Ag6, Ag7, Ag8, Ag9 and Ag10** are food grains, feed grains and hay, cotton, tobacco, oil-bearing crop, fruit and nuts, vegetable, meat animals, diary products, and poultry and egg.

Variable	Intercept	Δsize	ΔAAR	Δinter	Δbkcapita	agprice	ΔAg1	ΔAg2	ΔAg3	ΔAg4	ΔAg5	ΔAg6	ΔAg7	ΔAg8	ΔAg9	ΔAg10
Intercept	1	-0.0861	0.0031	-0.0132	0.275	-0.4849	0.0197	0.0307	0.0491	0.0171	0.0455	-0.0163	-0.0147	0.0029	0.0095	0.0083
Δsize	-0.0861	1	0.6824	-0.842	0.005	-0.1944	0.1787	0.3204	0.2747	0.0645	0.1279	0.0321	0.054	0.3501	0.1655	0.3728
ΔAAR	0.0031	0.6824	1	-0.7766	-0.0119	-0.0843	0.0854	0.1788	0.322	0.0318	0.211	0.0141	-0.0317	0.3888	0.3238	0.3281
Δinter	-0.0132	-0.842	-0.7766	1	0.0409	0.016	-0.2312	-0.4401	-0.3756	-0.08	-0.1858	-0.0422	-0.0683	-0.4921	-0.2234	-0.5277
Δbkcapita	0.275	0.005	-0.0119	0.0409	1	0.0104	0.0235	-0.0339	-0.0103	0.004	0.0041	0.0173	-0.0011	-0.0074	0.0148	-0.009
agprice	-0.4849	-0.1944	-0.0843	0.016	0.0104	1	-0.0001	0.0222	0.0208	-0.0035	0.0003	0.0085	0.0033	0.0413	-0.0319	0.042
ΔAg1	0.0197	0.1787	0.0854	-0.2312	0.0235	-0.0001	1	0.3091	0.3385	0.0438	0.2847	0.0805	0.0897	0.4581	0.0727	0.4351
ΔAg2	0.0307	0.3204	0.1788	-0.4401	-0.0339	0.0222	0.3091	1	0.6088	0.0411	0.237	0.1345	0.1293	0.5655	0.0679	0.5693
ΔAg3	0.0491	0.2747	0.322	-0.3756	-0.0103	0.0208	0.3385	0.6088	1	-0.0123	0.4158	0.1174	0.0872	0.45	0.1035	0.413
ΔAg4	0.0171	0.0645	0.0318	-0.08	0.004	-0.0035	0.0438	0.0411	-0.0123	1	-0.0181	0.0497	0.005	0.1315	0.1504	0.1821
ΔAg5	0.0455	0.1279	0.211	-0.1858	0.0041	0.0003	0.2847	0.237	0.4158	-0.0181	1	-0.0134	0.1007	0.2571	-0.0116	0.1894
ΔAg6	-0.0163	0.0321	0.0141	-0.0422	0.0173	0.0085	0.0805	0.1345	0.1174	0.0497	-0.0134	1	0.1438	0.1698	0.1055	0.208
ΔAg7	-0.0147	0.054	-0.0317	-0.0683	-0.0011	0.0033	0.0897	0.1293	0.0872	0.005	0.1007	0.1438	1	0.1372	-0.0978	0.1867
ΔAg8	0.0029	0.3501	0.3888	-0.4921	-0.0074	0.0413	0.4581	0.5655	0.45	0.1315	0.2571	0.1698	0.1372	1	0.1897	0.8805
ΔAg9	0.0095	0.1655	0.3238	-0.2234	0.0148	-0.0319	0.0727	0.0679	0.1035	0.1504	-0.0116	0.1055	-0.0978	0.1897	1	0.5283
ΔAg10	0.0083	0.3728	0.3281	-0.5277	-0.009	0.042	0.4351	0.5693	0.413	0.1821	0.1894	0.208	0.1867	0.8805	0.5283	1

TABLE 23. CORRELATION OF ESTIMATES OF CHANGE OF LOCAL ECONOMIC ACTIVITY EFFECT MODEL BASED ON NON-AGRICULTURAL BANKS' OBSERVATIONS BETWEEN 1988 AND 1992 PERIODS.

This table contains the correlation coefficient matrix of change of agricultural effect model based on non-agricultural banks' observations. Δ represents percentage change of the specified variable. **size** is the size of the bank. **AAR** is the average agricultural loan ratio. **Inter** is interaction term, testing the relationship between agricultural and bank's size. **Bkcapita** represents banks per capita in the county level. **Agprice** shows the volatility of agricultural loans. **Ag1, Ag2, Ag3, Ag4, Ag5, Ag6, Ag7, Ag8, Ag9 and Ag10** are food grains, feed grains and hay, cotton, tobacco, oil-bearing crop, fruit and nuts, vegetable, meat animals, diary products, and poultry and egg.

Variable	Intercept	Δsize	ΔAAR	Δinter	Δbkcapita	agprice	ΔAg1	ΔAg2	ΔAg3	ΔAg4	ΔAg5	ΔAg6	ΔAg7	ΔAg8	ΔAg9	ΔAg10
Intercept	1	-0.4279	-0.0302	0.021	0.421	-0.0995	-0.0176	-0.0186	0.0162	0.0041	0.0167	0.0097	-0.0012	0.0182	-0.0027	-0.0249
Δsize	-0.4279	1	0.1895	-0.2023	0.0172	-0.0631	-0.0018	-0.025	-0.0093	0.0074	0.0008	-0.0194	0.0255	0.0421	0.0214	0.0145
ΔAAR	-0.0302	0.1895	1	-0.9336	-0.0176	-0.0987	0.0469	-0.1401	-0.0601	-0.1108	-0.0823	-0.2023	-0.0029	0.1599	0.0574	0.0396
Δinter	0.021	-0.2023	-0.9336	1	0.0288	0.057	-0.0409	0.0281	0.0719	0.0086	0.0394	0.1373	-0.1391	-0.1735	-0.1652	-0.0418
Δbkcapita	0.421	0.0172	-0.0176	0.0288	1	-0.0045	0.0162	0.006	-0.0032	0.0014	-0.0163	0.0066	-0.0137	-0.0114	-0.0014	-0.0059
agprice	-0.0995	-0.0631	-0.0987	0.057	-0.0045	1	0.0298	0.1038	0.0016	0.0644	0.0119	-0.0639	-0.0215	-0.0084	0.1375	0.0666
ΔAg1	-0.0176	-0.0018	0.0469	-0.0409	0.0162	0.0298	1	0.3362	-0.3012	-0.1047	-0.4636	-0.0348	-0.0025	-0.2948	0.086	-0.1184
ΔAg2	-0.0186	-0.025	-0.1401	0.0281	0.006	0.1038	0.3362	1	-0.1564	-0.0866	-0.2669	0.1872	0.1669	-0.4796	0.3117	-0.1582
ΔAg3	0.0162	-0.0093	-0.0601	0.0719	-0.0032	0.0016	-0.3012	-0.1564	1	0.0451	0.6289	0.0365	-0.0601	0.3079	-0.0624	0.0998
ΔAg4	0.0041	0.0074	-0.1108	0.0086	0.0014	0.0644	-0.1047	-0.0866	0.0451	1	0.1653	0.1415	0.2354	0.3192	0.4033	0.0302
ΔAg5	0.0167	0.0008	-0.0823	0.0394	-0.0163	0.0119	-0.4636	-0.2669	0.6289	0.1653	1	0.0391	0.0572	0.4111	-0.0098	0.1477
ΔAg6	0.0097	-0.0194	-0.2023	0.1373	0.0066	-0.0639	-0.0348	0.1872	0.0365	0.1415	0.0391	1	0.5186	0.0809	0.0748	-0.0249
ΔAg7	-0.0012	0.0255	-0.0029	-0.1391	-0.0137	-0.0215	-0.0025	0.1669	-0.0601	0.2354	0.0572	0.5186	1	0.1476	0.2944	0.0588
ΔAg8	0.0182	0.0421	0.1599	-0.1735	-0.0114	-0.0084	-0.2948	-0.4796	0.3079	0.3192	0.4111	0.0809	0.1476	1	0.0546	0.2
ΔAg9	-0.0027	0.0214	0.0574	-0.1652	-0.0014	0.1375	0.086	0.3117	-0.0624	0.4033	-0.0098	0.0748	0.2944	0.0546	1	-0.1113
ΔAg10	-0.0249	0.0145	0.0396	-0.0418	-0.0059	0.0666	-0.1184	-0.1582	0.0998	0.0302	0.1477	-0.0249	0.0588	0.2	-0.1113	1

Table 24. Change of local economic effect model based on X-efficiency change between 1992 and 1997.

This table contains the results of the estimation of the relationship between the change of bank's X-efficiency (1992-1997) and the changes of bank's fundamental information and agricultural factors effects (1988-1992). ΔSize is the percentage change of bank's size, measured by total assets in logarithm term. ΔAAR is the percentage change of agricultural loan ratio, calculated from the average agricultural loans divided by the total assets of the bank. ΔInter is percentage change of interaction term, testing the relationship between agricultural loans and bank's size. ΔBkcapita represents the percentage change of banks per capita at the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on quarterly data of average agricultural loans over 10-year examination period. AgR is agricultural products ratio. Δ(AgR*AAR) represents the percentage change of agricultural loans on the specified agricultural products at the county level.

$$\Delta XEFF_i = a + b_1 \Delta size_i + b_2 \Delta AAR_i + b_3 \Delta Inter_i + b_4 \Delta bkcapita_i + b_5 Agprice_i + \sum_{j=1}^{10} r_j \Delta (AgR_{ji} * AAR_i)$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variables			
Intercept	-0.00598***	-0.00489***	-0.00607***
Δsize	0.00033719**	0.00048794	0.00058088***
ΔAAR	6.21E-06	0.00301***	5.97E-06
Δinter	-3.36E-06	-0.00072735	-4.54E-06
Δbkcapita	0.00090138*	0.00104	0.0008212
agprice	-6.44E-09	-6.55E-07***	6.10E-09
ΔFood Grains	-0.00104	-0.04518**	-0.00092753
ΔFeed Grains and Hay	0.000187	-0.00965	0.00024445
ΔCotton	0.00050344	-0.0228*	0.00054114
ΔTobacco	0.00002577	-0.10522	5.38E-05
ΔOil-Bearing Crop	0.00128**	0.01415	0.00129**
ΔFruit and Nuts	-0.00060253	0.12949	-0.0006462
ΔVegetable	0.00050578	0.05056	0.00050025
ΔMeat Animals	0.00011158	0.01576	0.00011055
ΔDiary Products	-0.00021002	-0.02329	-0.0001638
ΔPoultry and Eggs	0.00179***	0.00612	0.00183***
Adj R-Sq	0.0011	0.0128	0.0019

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively.

TABLE 25. CHANGE OF LOCAL ECONOMIC EFFECT MODEL BASED ON X-EFFICIENCY CHANGE BETWEEN 1988 AND 1997.

This table contains the results of the estimation of the relationship between the percentage change of bank's X-efficiency (1988-1997) and the percentage changes of bank's fundamental information and agricultural factors effects (1988-1992). ΔSize is the percentage change of bank's size, measured by total assets in logarithm term. ΔAAR is the percentage change of agricultural loan ratio, calculated from the average agricultural loans divided by the total assets of the bank. ΔInter is percentage change of interaction term, testing the relationship between agricultural loans and bank's size. ΔBkcapita represents the percentage change of banks per capita at the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on quarterly data of average agricultural loans over 10-year examination period. AgR is agricultural products ratio. Δ(AgR*AAR) represents the percentage change of agricultural loans on the specified agricultural products at the county level.

$$\Delta XEFF_i = a + b_1 \Delta size_i + b_2 \Delta AAR_i + b_3 \Delta Inter_i + b_4 \Delta bkcapita_i + b_5 Agprice_i + \sum_{j=1}^{10} r_j \Delta(AgR_{ji} * AAR_i)$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variables			
Intercept	-0.0099***	-0.00615***	-0.01101***
Δsize	0.00198***	0.00411***	0.00229***
ΔAAR	7.45E-05**	0.00235*	7.27E-05**
Δinter	-5.31E-05**	-0.00069532	-4.95E-05**
Δbkcapita	0.00154***	0.00119	0.00049986
agprice	1.11E-07***	-9.69E-07***	1.26E-07***
ΔFood Grains	-0.00101	-0.07914***	-0.00061653
ΔFeed Grains and Hay	-0.00039865	-0.06039***	-0.00020762
ΔCotton	0.00124*	-0.05424***	0.00116*
ΔTobacco	-0.00051782	0.21912	-0.00054883
ΔOil-Bearing Crop	0.00133**	-0.00714	0.00117*
ΔFruit and Nuts	-0.00239***	-0.25684	-0.00243***
ΔVegetable	-0.00013437	0.17669**	-0.00016336
ΔMeat Animals	6.87E-05	-0.00375	1.55E-05
ΔDiary Products	-0.00031403	-0.15883***	-0.00029746
ΔPoultry and Eggs	0.0014**	-0.0235	0.00152***
Adj R-Sq	0.0091	0.021	0.0145

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively.

TABLE 26. PRICE VOLATILITY OF AGRICULTURAL PRODUCTS

The price volatility of the agricultural products is calculated based on the monthly price index of each products during the periods between 1988 and 1997.

Agricultural Products Categories	Price Volatility
Food Grains	0.04410
Feed Grains and Hay	0.04319
Cotton	0.04059
Tobacco	0.07272
Oil-Bearing Crop	0.04334
Fruit and Nuts	0.08198
Vegetable	0.15201
Meat Animals	0.02540
Diary Products	0.03154
Poultry and Egg	0.04085

TABLE 27. THE DESIGN OF DUMMY VARIABLE FOR THE FUTURE CONTRACT

The dummy variables are designed for distinguishing the risk exposure of the bank. If the risk is hedged, the dummy variable is 0. If the risk is not hedged, the bank has the exposure to the risk and the dummy is 1.

Availability of commodity in the county level	Availability of the Future Contract	Risk Exposure	Dummy Variable
Available	Available	Hedged	0
Available	Not Available	Not Hedged	1
Not Available	Available	Hedged	0
Not Available	Not Available	Hedged	0

TABLE 28. AVAILABILITY OF FUTURE CONTRACTS IN DIFFERENT SECTORS

Future Contract Listings	
Energies	**Financials**
Crude Oil	U.S. Treasury Bonds
Heating Oil	U.S. Treasury Notes
Unleaded Gas	U.S. Treasury Bills
Natural Gas	U.S. Eurodollars
Propane	Euroyen
Tropicals	**Grains**
Coffee	Soybeans
Cocoa	Bean Oil
Sugar	Bean Meal
Orange Juice	Corn
Cotton	Wheat
Lumber	Oats
Meats	**Stock Indices**
Pork Bellies	Dow Jones Index
Lean Hogs	NASDAQ 100 Index
Live Cattle	S&P 500 Index
Feeder Cattle	Value Line
	Russell 200
Metals	**E-Mini's (electronic minis)**
Gold	E-Mini Yen
Silver	E-Mini Euro Currency
Platinum	E-Mini S&P 500
Palladium	E-Mini NASDAQ 100
Copper	
Midam Contracts	**Currencies**
Corn	Euro Currency
Soybeans	Swiss Franc
Soymeal	Japanese Yen
Wheat	US Dollar Index
Live Cattle	British Pound
Lean Hogs	Canadian Dollar
US Treasury Bonds	Australian Dollar
Swiss Franc	
Japanese Yen	
British Pound	

Data source: ALTAVEST Worldwide Trading, Inc http://www.altavest.com/

TABLE 29. AGRICULTURAL PRICE RISK EFFECT MODEL RESULTS

This table contains the results of the estimations of the relationship between banks' X-efficiency, banks' fundamental information and banks' agricultural price risk. **size** is the size of the bank, measured by total assets in logarithm term. **AAR** is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets. **Inter** is interaction term, testing the relationship between agricultural loan ratio and banks' size. **Bkcapita** represents banks per capita at the county level. **Agprice** shows the volatility of agricultural loans based on the quarterly data of average agricultural loans. **XEFF** is the quarterly average efficiency of each commercial bank in 1992. AgR is agricultural products ratio. AgR*AAR represents agricultural loans on the specified agricultural products at the county level. AgPV is the price volatility of agricultural. DumFC is the design of the dummy variable for risk exposure.

$$XEFF_i = \boldsymbol{a} + \boldsymbol{b}_1 size_i + \boldsymbol{b}_2 size^2{}_i + \boldsymbol{b}_3 size^3{}_i + \boldsymbol{b}_4 AAR_i + \boldsymbol{b}_5 Inter_i + \boldsymbol{b}_5 bkcapita_i$$
$$+ \boldsymbol{b}_6 Agprice_i + \sum_{j=1}^{10} \boldsymbol{r}_j (AgR_{ji} * AAR_i) + \sum_{j}^{10} \boldsymbol{w}_j (AgPV_{ji} * DumFC_{ji})$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variables			
Intercept	1.12199***	2.8236***	1.10241***
size	-0.04487***	-0.55239***	-0.03787***
$size^2$	0.00369***	0.05338***	0.00297***
$size^3$	-9.23E-05***	-0.0017***	-6.98E-05***
AAR	-0.17767***	-0.12551***	-0.34406***
Inter	0.01537***	0.01303***	0.02804***
Bkcapita	4.84658***	5.15926***	8.50451***
Agprice	-4.13E-09	-7.63E-07***	-1.48229E-08
Food Grains	0.01614***	-0.00217	0.00393
Feed Grains and Hay	0.05284***	0.03189***	0.08789***
Cotton	-0.00054965	-0.00037908	-0.023**
Tobacco	0.03251**	0.05549	0.04742***
Oil-Bearing Crop	0.03858***	0.02158***	0.09767***
Fruit and Nuts	-0.04351***	-0.0421**	-0.01804
Vegetable	-0.05646***	-0.10811***	0.01879
Meat Animals	0.02066***	0.00449	0.02154***
Diary Products	0.05466***	0.04849***	0.08008***
Poultry and Egg	0.01139**	-0.00912	0.0396***
Price Risk of Food Grains	0	0	0
Price Risk of Feed Grains and Hay	0	0	0
Price Risk of Cotton	0	0	0
Price Risk of Tobacco	0.01137***	0.10145***	0.00789**
Price Risk of Oil-Bearing Crop	0	0	0
Price Risk of Fruit and Nuts	-0.00486***	-0.00211	-0.00422**
Price Risk of Vegetable	-0.0034***	-0.00098792	-0.00385***
Price Risk of Meat Animals	0	0	0
Price Risk of Diary Products	0.04511***	0.13933***	0.03489***
Price Risk of Poultry and Egg	0.01758***	0.00090549	0.01861***
Adjust R^2	0.1222	0.2218	0.1156

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively.

TABLE 30. ADJUSTED R SQUARE OF MODELS BASED ON DIFFERENT SIZE AND LOAN SPECIALIZATION

Model 1, model 2, and model 3 represent bank fundamental information effect model, local economic activity effect model, and agricultural price risk effect model. M and B represent million and billion dollars. All, Ag, and Nag are the models examined based on all banks', agricultural banks' and non-agricultural banks' observation, respectively.

Adjusted R2	Model1			Model2			Model3		
Size	All	Ag	Nag	All	Ag	Nag	All	Ag	Nag
All	0.0341	0.086	0.0341	0.1197	0.2123	0.1137	0.1248	0.2267	0.1178
<10M	0.1081	0.1028	0.1444	0.1275	0.137	0.1779	0.1503	0.1678	0.2003
10-20M	0.0127	0.025	0.0408	0.0688	0.1196	0.0714	0.07	0.1308	0.0751
20-30M	0.0114	0.0257	0.0053	0.0906	0.1375	0.0581	0.0966	0.1819	0.0644
30-40M	0.0235	0.0402	0.0105	0.1223	0.1605	0.0843	0.1368	0.1888	0.1017
40-50M	0.0428	0.0481	0.0243	0.1625	0.1927	0.1053	0.1735	0.2148	0.1186
50-60M	0.0509	0.1058	0.0335	0.1783	0.2974	0.1273	0.1921	0.3322	0.1401
60-70M	0.0415	0.0902	0.0243	0.1713	0.2726	0.1193	0.1808	0.3328	0.1284
70-80M	0.0396	0.0797	0.0323	0.1303	0.345	0.1154	0.1453	0.4617	0.1319
80-90M	0.038	0.0718	0.0335	0.183	0.3752	0.1729	0.2007	0.4139	0.1895
90-100M	0.0341	0.0758	0.0275	0.1265	0.2206	0.1047	0.14	0.1907	0.1193
100-150M	0.0276	0.0945	0.0239	0.0899	0.3262	0.0669	0.0962	0.4411	0.0717
150-200M	0.0244	0.3349	0.0245	0.0796		0.0594	0.1015		0.0819
200-250M	0.0177	0.2764	0.0179	0.0938		0.086	0.114		0.1037
250-300M	0.0215	0.06	0.0214	0.06		0.0636	0.108		0.112
300-400M	0.0093	0.1119	0.0088	0.093		0.0925	0.1094		0.1088
400-500M	0.0142	0.3725	0.0139	0.0423		0.0446	0.0904		0.0897
500-600M	0.0231		0.0228	0.1699		0.1699	0.2012		0.2012
600-700M	0.0303		0.0304	0.0922		0.0922	0.2176		0.2176
700-800M	0.0229		0.0229	0.06		0.06	0.2894		0.2894
800-900M	0.006		0.006	-0.0314		-0.0314	0.0952		0.0952
900-1000M	0.0136		0.0136	0.0447		0.0447	0.152		0.152
1-1.5B	0.0268		0.0268	0.1476		0.1476	0.2293		0.2293
1.5-2B	0.0279		0.0279	0.1134		0.1134	0.2617		0.2617
2-3B	0.0366		0.0366	0.222		0.222	0.333		0.333
3-5B	0.0166		0.0166	0.1282		0.1282	0.2126		0.2126
5-10B	0.0415		0.0415	0.1092		0.1092	0.2646		0.2646
>10B	0.1264		0.1264	0.1901		0.1901	0.7123		0.7123

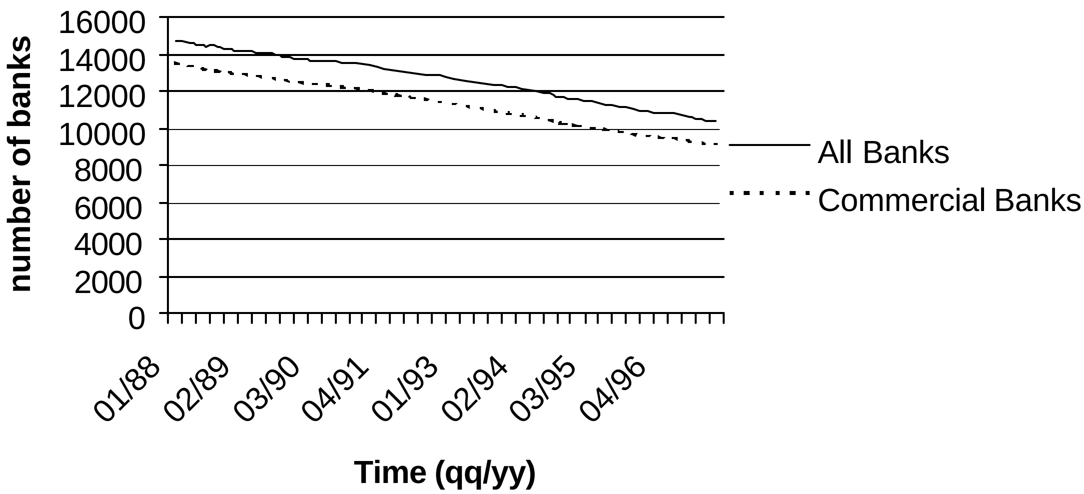

FIGURE 2. THE NUMBER OF ALL U.S. BANKS AND U.S. COMMERCIAL BANKS

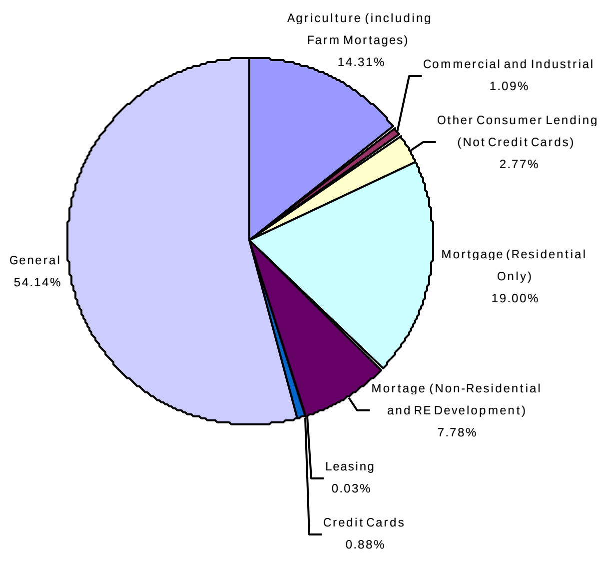

FIGURE 3. NUMBER OF SPECIALTY BANK, 1996

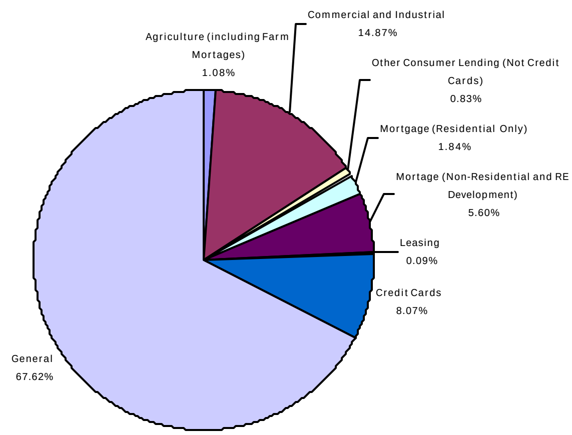

FIGURE 4. MANAGED ASSETS OF SPECIALTIES BANKS, 1996

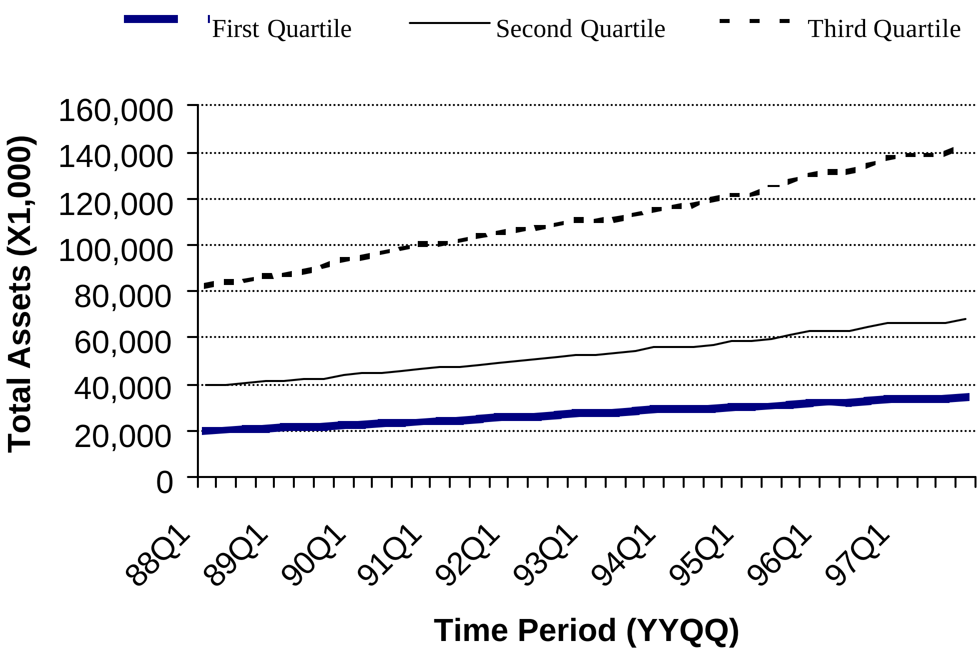

FIGURE 5. QUARTILE CRITERION BOUNDARIES BASED ON BANK'S SIZE
The trend of the bank's size quartile boundaries is increasing through the examination periods.

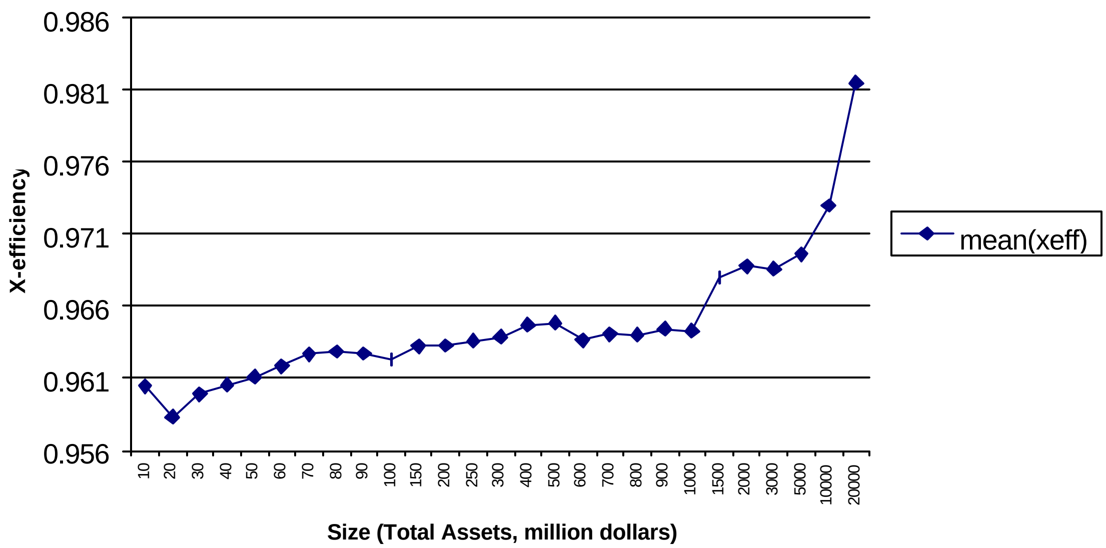

FIGURE 6. X-EFFICIENCY OF ALL COMMERCIAL BANKS
Every data point is the quarterly average X-efficiency of all commercial banks in the smaller size category during the examination period (1988-1997)

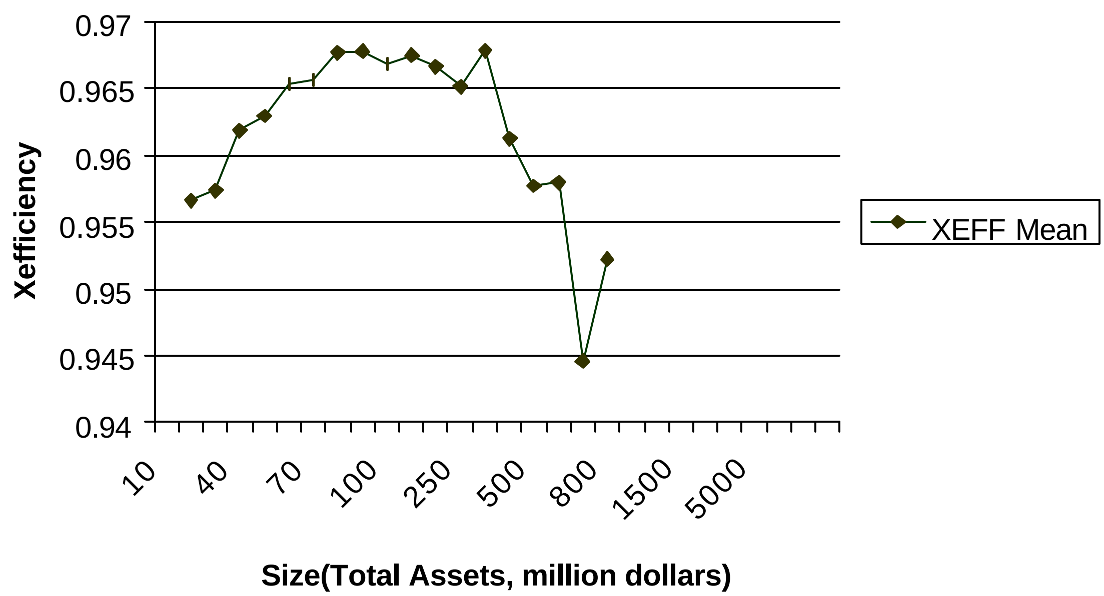

FIGURE 7. X-EFFICIENCY OF COMMERCIAL BANKS WITH SPECIALIZATION IN AGRICULTURAL LOANS
Every data point is quarterly average of X-efficiency of commercial banks with specialization in agricultural loans during the examination period (1988-1997).

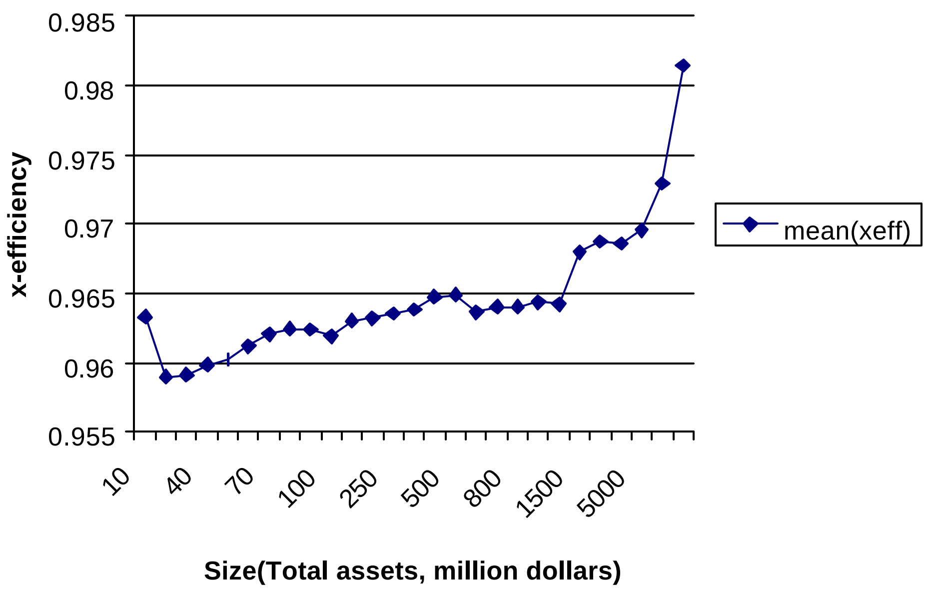

FIGURE 8. X-EFFICIENCY OF COMMERCIAL BANKS WITHOUT SPECIALIZATION IN AGRICULTURAL LOANS

Every data point is quarterly average of X-efficiency of commercial banks without specialization in agricultural loans during the examination period (1988-1997).

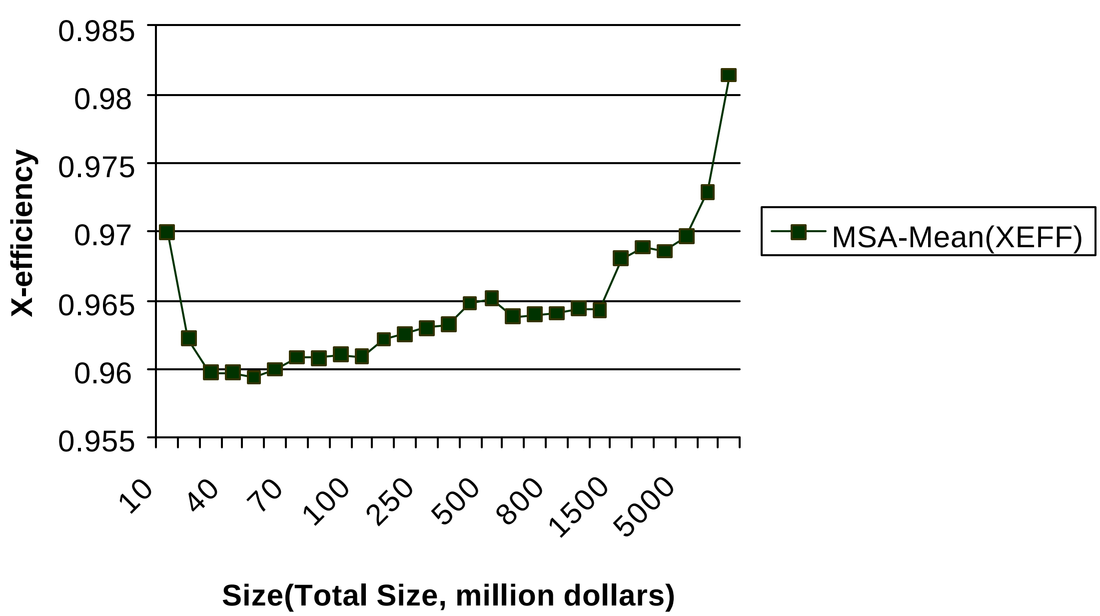

FIGURE 9. X-EFFICIENCY OF COMMERCIAL BANKS CHARTERED IN MSA AREAS

Every data point is quarterly average of X-efficiency of commercial banks chartered in a MSA during the examination period (1988-1997).

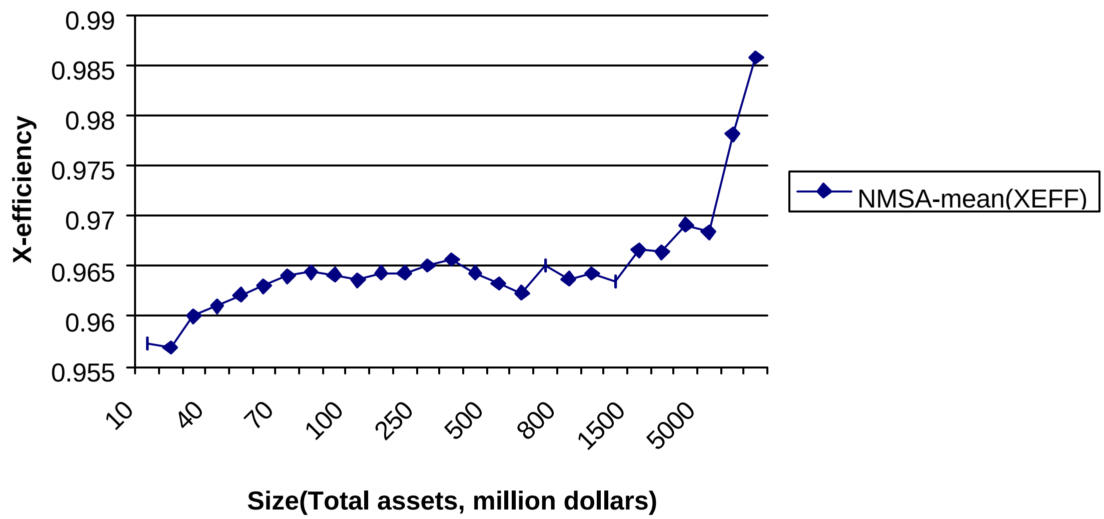

FIGURE 10. X-EFFICIENCY OF COMMERCIAL BANKS CHARTERED IN NON-MSA AREA
Every data point is quarterly average of X-efficiency of commercial banks chartered in non-MSA during the examination period (1988-1997).

CHAPTER 4

DOES BANK EFFICIENCY CHANGE WITH THE BUSINESS CYCLE? THE RELATIONSHIP BETWEEN MONETARY POLICY, ECONOMIC GROWTH, AND BANK CONDITION

4.1 Abstract

The goal of this essay is to examine estimates of individual bank X-efficiency across time. First, we estimate a translog flexible function specification of bank efficiency during the period 1988-1997. Then, we estimate a time-series/cross-sectional model with independent variables that reflect business cycle and monetary policy conditions that may affect bank performance. Like Calomiris and Mason (1997, 2000), we find that leading business conditions are positively related to bank performance. Though this result suggests that regulators should attempt to anticipate business cycle downturns and influence bank portfolio risk accordingly, the business condition elasticity of bank X-efficiency is low enough to suggest that the banking sector is not significantly susceptible to a systemic event due to business cycle conditions alone. Lead and lag relationship between large and small banks are also examined. Like Gilbert (1997), the entrance of large banks into the local financial market does enhance small bank efficiency simultaneously.

4.2 Introduction

Given that banks are intermediaries in the financial market, the operation of banks may be highly correlated to the pulse of the macro economy. For example, the outputs of commercial banks, commercial loans, real estate loans, agricultural loans, individual loans, checking, saving and time deposits, are closely tied to the interest rates in the macro economy. Monetary policy may directly or indirectly affect the outputs of commercial banks. Moreover, the price input variables of commercial banks' operation, including total interest expenses, occupancy expenses, furniture, equipment and other non-interest expenses, and salaries and employees benefits are also correlated with interest rates and, thus, the whole macro economic situation. Since the translog function, which is used to the cost efficiency of commercial banks, is a function of a bank's output and input factors, the results and the extension of the translog function may be impacted by macro economic factors.

We examine these effects through estimates of individual bank X-efficiency estimates across time. First, we estimate a translog flexible function specification of bank efficiency during the period 1988-1997 (Berger, Hunter, and Timme 1993; Peristiani 1997). Then, we estimate a cross sectional model with independent variables that reflect business cycle and monetary policy conditions that may affect bank performance. Like Calomiris and Mason (1997), we hypothesize that leading business conditions are positively related to bank performance. Though this result suggests that regulators should attempt to anticipate business cycle downturns and influence bank portfolio risk accordingly, the business condition elasticity of bank X-efficiency is low enough to suggest that the banking sector is not significantly susceptible to a systemic event due to business cycle conditions alone.

Most literature on bank failures tends to deal with incidents of financial crisis, panic, or contagion. Some, such as Wigmore (1987) and Donaldson (1992), attribute these episodes primarily to speculative attacks on the numeraire or illiquidity shocks by Diamond and Dybvig (1983) and Donaldson (1993), whereas others attribute these episodes to increased asymmetric information regarding the incidence of financial distress, shown by Calomiris and Kahn (1991); Bhattacharya and Thakor (1993); Kaufman (1994), and; Calomiris and Mason (1997). Recent corporate bankruptcy literature further distinguishes between failure arising from systemic events like crisis, panic, or contagion, and unrelated financial pressures (Denis and Denis 1995).

Though effective safety and soundness regulation should mitigate the risk of bank failures attributable to individual bank effects like fraud and mismanagement, the industry could still be susceptible to financial weakness arising from a general deterioration in economic conditions. Such an occurrence could presumably lead to conditions of increased bank weakness that would cause a systemic crisis, panic, or contagion. Jensen, Mercer,and Johnson (1996), Kleim and Stambaugh (1986), Campbell (1987), Fama and French (1988, 1989), Schwert (1990), and Howton and Peterson (1998) all provide evidence that business conditions proxies like dividend yields, default spreads, and term spreads explain significant variation in stock and bond spreads. We hypothesize that similar indicators reflect the diversification and flexibility of bank loan portfolios. Changes in portfolio condition will ultimately affect bank earnings and expenses like interest revenue and loan chargeoffs.

In Figure 11, we can observe that there is a pattern in the time series of the efficiency for banks in metropolitan statistical areas (MSAs). There may be some macro economic factors that impact this pattern. Thus, in this study, we try to test two hypotheses. First, business cycle conditions may be correlated with the total efficiency of banks. We examine the time series properties of bank efficiency to determine if bank efficiency has a lead or lag response to business cycle conditions. Second, we will test whether a monetary policy change will affect the efficiency of the banks. Again, we examine lead and lag relationships between the monetary policy change and the efficiency change. Therefore, in this study, the relationship between macro economic factors and commercial banks' X-efficiency will be investigated. Additionally, we examine if there is a lead/lag pattern in the efficiencies of banks of different sizes. Previous results in essay I show economies of scale in the bank industry as a whole. Thus, it is possible that increase in efficiency by large banks may be causing efficiency improvement in smaller banks.

4.3 Literature Review

Diamond and Dybvig (1986) argued that bank regulatory policies regarding the involvement of the banking industry in the money supply process are an important determinant of the survival of banks. If the regulatory policies were made solely based on macroeconomic goals, there might be no need for banks as other existing institutions, such as mutual funds, can substitute for the roles of banks. Thus, regulatory policies might affect the operation efficiency of banks. During the examination period of this study, there are the three important regulatory polices related to the banking industry. They are 1989 Financial Institutions Reform Recovery and Enforcement Act (FIRREA), the 1991 Federal Deposit Insurance Corporation Improvement (FDICIA), and the 1994 Riegle-Neal Interstate Banking and Branching Efficiency Act. Regulation in the banking industry may also influence the efficiency of the banking industry. The information and purposes of those acts are discussed in Table 31. Many studies show that there is an impact on banks from major regulatory changes. For example, Allen and Wilhelm (1988) showed that there was a significant effect on the banking industry from the enactment of the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980 on the financial institutions. Cornett and Tehranian (1990) examined the impact of the Depository Institutions Act of 1982 (Garn-St. Germain) on commercial banks and savings and loans. They found positive abnormal returns to stockholders of large savings and loans and commercial banks from the enactment of the Garn-St. Germain Act. Stockholders of small savings and loans and commercial banks experienced negative abnormal returns. If legislation changes affect banks' X-efficiencies, different reactions of banks' shareholders are expected. Evanoff (1998) assessed the impact of regulation on bank cost efficiency. He assumed that the 1980 Depository Institution Deregulation and Monetary Control Act and the 1982 Garn-St Germain Act relaxed constraints on industry prices, products, and geographic expansion. He found an approximately 7% cost saving after the deregulation. During the eight-year regulation period, 1972-1979, technology decreased costs only by 5%. He concluded that 2% of cost saving was caused by the deregulation. He explained that the deregulation increased banks' ability and incentives to take advantage of employing more efficient production techniques.

In terms of the financial institution risk perspective, regulatory changes can affect the risk of the commercial banks. Bundt, Cosimano, and Halloran (1992) and Madura and Wiley (2000) examine the impact of the DIDMCA and FIRREA, respectively, on financial institutions. Madura and Wiley (2000) showed that smaller saving institutions have more reduction in interest rate risk and real estate risk than the larger institutions after FIRREA. FDICIA might also play an important role in the banking industry. One of the important features of the FDICIA is to provide greater discipline against excessive risk taking by banks. Carow and Larsen Jr. (1997) examine market reaction to legislative announcements surrounding the passage of the FDICIA of 1991. Their results showed that FDICIA affected shareholder wealth adversely. They also concluded that the removal of Federal regulator's discretionary authority and the imposition of mandatory regulations in the FDICIA had a negative influence on the bank holding companies.

DeYoung (1998) asserted that deregulation might enhance industry productivity in general. However, removing a long-standing regulation was unlikely to provide a Pareto improvement. If state laws, which prevent local banks from the entry of large out-of-state competitors, functioned as anticompetitive entry barriers, the X-efficiency of local banks should have improved most in the markets where entry from out-of-state banks was the most intense. If state laws were to preserving local control over the financial infrastructure, the improvement of the X-efficiency might not be that significant. DeYoung, Hasan, and Kirchhoff (1998) investigated X-efficiency of local commercial banks in 1994 and tested the relationship between the local market cost efficiency and the deregulation of out-of-state entry[37]. They found that the initial period of the entry of large out-of-state competitors decreased the local market cost efficiency. However, in the long run, the cost efficiency improved with increased entry of out-of-state banks. They also expected that similar efficiency improvements in local market after the realization of the Riegle-Neal Act in the beginning of 1997. Carow and Heron (1998) also found that there was a positive wealth effect on a sample of large bank holding company after the passage of the Riegle-Neal Act.

King and Levine (1993) show cross-country evidence that financial systems promote economic growth. They examine the relationship between the level of financial

---

[37] Those banks were operated primarily in a single metropolitan area in 1994. The deregulation is based on

development and future rates of long-run economic growth, physical capital accumulation, and economic efficiency improvement on 80 countries over the 1960-1989 periods. The results showed a robust relationship between the level of financial development and both the current and future rate of economic growth, which is measured by the real per capita GDP. Given that commercial banks are intermediaries in the financial markets, the change of commercial banks' efficiency might be related to the economic growth. Thakor (1998) showed that the relationship between banks and the capital market is competitive and complementary. He suggested that banks' inefficiency led borrowers away from the market. In other words, improvements in banks' efficiency enhanced borrowers to access the market. Berger, Kyle, and Scalise (1999) provided some support that supervisory toughness, which might influence bank lending, was affected by business conditions. Supervisory toughness increased during the credit crunch period (1989-1992) and decreased during the boom period (1993-1998). Berger, Bonime, Covitz, and Hancock (2000) found that local, state, and regional shocks continued to affect the relative performance of the banks at both the high and low end of the distribution. They suggested that banks manage risk with greater geographic diversification and greater use of financial engineering techniques still can not significantly decrease the impacts from the regional and macroeconomic shocks.

Riegle-Neal Interstate Banking and Branching Act Efficiency Act of 1994.

There are several studies that employ different variables as the proxy of the business conditions and monetary policy. Bhardwaj and Brooks (1993) and Howton and Peterson (1998) differentiated the bull and bear quarter using the following criteria[38]. First, the market return is defined as the CRSP NYSE/AMEX/Nasdaq equal-weighted index returns during the examination period. The median market return is picked as the standard to classify the bull and bear markets. If the market return is higher the median, it is classified as a bull market period. If it is below the median, it is a bear market period. Lakonishok and Shapiro (1984) and Pettengill, Sundaram, and Mathur (1995) differentiated up and down markets by using the market excess returns. Market excess returns are defined as the difference between the market returns and the risk-free rate. Up markets have positive market excess returns and down markets have negative market excess returns. Friedman and Schwartz (1963), Sims (1972), and Christiano and Ljungqvist (1988) showed that business conditions have a linkage with monetary aggregates. Moreover, Lynge (1981), Cornell (1983), and Pearce and Roley (1983) also found that monetary policy, as measured by money supply announcements affected the financial market. Federal Reserve discount-rate changes also have similar impacts on financial markets as well (Waud (1970), Smirlock and Yawitz (1985), Pearce and Roley

---

[38] Bhardwaj and Brooks (1993) found a strong correlation between their classifications of bull and bear markets with the situation of business cycle highs and lows. Howton and Peterson (1998) used bull and bear months as business cycle conditions. In this study, in order to be consistent with the quarterly data from the Call Report, we decide to employ bull and bear quarters as the measure of the business cycle conditions.

(1985), and Cook and Hahn (1988)). Bernanke and Blinder (1992) found that federal funds premium, which is the difference between the federal funds rate and the three-month Treasury-bill rate, can be regarded as an indicator of monetary policy developments.

4.4 Data and Methodology

X-efficiency is the approach that we employ to measure the efficiency of banks. The Reports of Condition and Income Report Guide (Call Report) is the source of the banks' output and input data. The study period is from the first quarter of 1988 to the fourth quarter of 1997. We use the translog flexible function form to estimate the cost structure of banks and to derive the measure of the bank efficiency.[39] The translog function has been widely used to analyze the cost characteristics of depository institutions.[40] The standard tranlog function is given by the following:

$$
\begin{aligned}
\ln TC_{ti} = {} & a_0 + \sum_{k=1}^{6} b_k \ln(y_{kti}) + \sum_{l-1}^{4} a_l \ln(p_{lti}) + 0.5\sum_{k=1}^{6}\sum_{j=1}^{6} b_{kj} \ln(y_{kti}) \ln(y_{jti}) \\
& + 0.5\sum_{l=1}^{4}\sum_{h=1}^{4} a_{lh} \ln(p_{lti}) \ln(p_{hti}) + \sum_{k=1}^{6}\sum_{l=1}^{4} d_{lk} \ln(y_{kti}) \ln(p_{lti}) + \ln(x_{ti}) + u_{ti}, \qquad (17)
\end{aligned}
$$

---

[39] The translog function is also used as the cost equation in Mester (1987) and English et al. (1993)
[40] See the survey of Berger, Hunter, and Timme (1993)

where x_{ti} represents the X-efficiency factor and u_{ti} is the random error. The current specification assumes six standard bank outputs and four input prices. The specifications are the following:

TC_{ti} = total costs of bank i at time t = (total operating expenses + interest expenses)

y_k = bank outputs; (k=1) real estate loans, (k=2) agricultural loans, (k=3) commercial and industrial loans, (k=4) loans to individual for household, family, and other personal expenditures, (k=5)deposit liability – transaction accounts, and (k=6) deposit liability – nontransaction accounts.

p_l = price inputs; (l=1) total interest expenses, (l=2) price of capital (occupancy expenses, furniture, equipment and other non-interest expenses), and (l=3) salaries and employees benefits.

Cost-share equations are derived from Shephard's Lemma as follow:

$$\frac{\partial \ln TC_{ti}}{\partial \ln(p_{lti})} = S_{lti} = a_l + \sum_{h=1}^{4} a_{lh} \ln(p_{hti}) + \sum_{k=1}^{6} d_{lk} \ln(y_{kti}), \tag{18}$$

A share equation is omitted in order to prevent singularity. We estimate the equation formed by equation (17) and (18) subject to homogeneity and symmetry restrictions by the method of seemingly unrelated regressions (SUR).

If a firm systematically incurs relatively higher costs than the other firms in a competitive environment, it is considered X-inefficient. In the survey of Berger, Hunter, and Timme (1993), there are several econometric and linear programming techniques have been proposed for estimating X-efficiency. They are Econometric Frontier Approach (EFA), Thick Frontier Approach (TFA), Data Envelopment Analysis (DEA), and Distribution-Free Approach (DFA). In this study, we assume the efficiency differences are stable over time, and the random error averages out over time. Thus, we employ the distribution-free approach proposed by Berger (1993) to estimate the efficiency of the banks[41]. From equation (17), we can define $e_{ti} = \ln(x_{ti}) + u_{ti}$. Peristiani (1997) indicates that residual can be transformed so that the minimum is zero. Thus:

$$\hat{e}_{ti} = \min\{\hat{e}_{ti}\} - \hat{e}_{ti} . \qquad (19)$$

---

[41] See also the discussion in DeYoung (1997) for a diagnostic test for the distribution –free efficiency estimator.

By taking the exponential of equation (19), we can obtain the efficiency as

$$XEFF_{ti} = \exp(\hat{e}_{ti}), \qquad (20)$$

Thus, $XEFF_{ti}$ is normalized to fall between zero and one. However, $XEFF_{ti}$ is not robust to outliers. Berger modifies the observations so that observations falling below the p-th percentile are set to the p-th percentile value ($\hat{e}_{ti}^{(p)}$), and observations that exceed the (1-p)-th percentile are valued at ($\hat{e}_{ti}^{(1-p)}$). Thus, the modified X-efficiency can be defined as:

$$XEFF_{ti}(p) = \exp[\hat{e}_{ti}^{(p)} - \max\{\hat{e}_{t}^{(p)}, \min\{\hat{e}_{ti}, \hat{e}_{t}^{(1-p)}\}], \qquad (21)$$

All commercial banks are used to form the cost frontier. The criteria that we use as a filter is that the charter type in the call report should be 200, 210, 250, or 340, and the primary issuer code and total assets are both greater than zero. The valid quarterly X-efficiency observations are shown in Table 32. Table 32 also shows summary statistics of all commercial banks X-efficiency in each examining period. The information related to business cycles comes from the Conference Board's Business Cycle Indicators web site. Interest rate information, such as prime interest rates and the monetary policy components, comes from the Federal Reserve Board of Governors. The gross domestic product (GDP) and industry production index are also from the same resource as well. The CRSP NYSE/AMEX/Nasdaq equal-weighted market index is used to represent the condition of the stock market.

In this study, we investigate the relationship between the banks' X-efficiency and macro economic factors. We employ the similar approach of business conditions, such as dividend yields, default spread, term spread, and Federal Reserve discount-rate changes, as the proxy of the monetary policy conditions, like Jensen, Mercer, and Johnson (1996). Because the examination period from 1988 to 1997 is during the unit-banking era, a variable measuring commercial banks per capita is also considered. In addition, seasonal effects are also included in the regression analysis. Three dummy variables are set to differentiate the four quarters of the year. The unemployment rate is also used as a proxy of economic conditions. Regression analysis will be conducted to examine the determinants of X-efficiency change. The model can be written as follows:

$$\begin{aligned}\Delta XEFF_{it} &= \alpha + \beta_1 \Delta Size_{it} + \beta_2 \Delta TL_{it} + \beta_3 MR_{it} + \beta_4 BB_{it} + \beta_5 DP_{it} + \beta_6 DEF_{it} + \beta_7 DIR_{it} \\ &+ \beta_8 FFP_{it} + \beta_9 \Delta BPC_{it} + \beta_{10} SEASON_{it} + \beta_{11} \Delta GDP_{it} + \beta_{12} \Delta UNEMP_{it} \\ &+ \beta_{13} \Delta LEAD_{it} + \beta_{14} FIRREA_{it} + \beta_{15} FDICIA_{it} + \beta_{16} RNIBBEA_{it} + \varepsilon_{it} \qquad (22)\end{aligned}$$

$\Delta XEFF_{it}$ is the percentage change of X-efficiency of the individual commercial bank i at t time period. MR is the market return, which is the return of CRSP NYSE/AMEX/Nasdaq equal-weighted market index. BB is the dummy variable of the bull and bear markets, which 1 means bull market and 0 means bear market. The criteria used in Bhardwaj and Brooks (1993) and Howton and Peterson (1998) to differentiate the bull and bear quarter are employed. First, the market return is defined as the CRSP NYSE/AMEX/Nasdaq equal-weighted index returns during the examination period. The median market return is picked as the standard to classify the bull and bear markets. If the market return is higher the median, it is classified as a bull market period, which is defined as 1. If it is below the median, it is a bear market period, which is defined as 0.

ΔSize is the percentage change of the bank size. Total assets of the bank are regarded as the proxy of the bank size. ΔTL is the percentage change of the total loans. Chen, Mason, and Higgins (2000) found the relationship between X-efficiency and bank size. The size of total loans also impacts the cost efficiency of banks. DP represents the market dividend yield. The procedure is to calculate the dividend yield similar with that of Fama and French (1988) and Jensen, Mercer, and Johnson (1996). Quarterly CRSP NYSE/AMEX indexes are used to compute the quarterly dividend. The dividend yield in quarter t is derived by the sum of quarterly dividends between the quarter t-3 and quarter t and divided by the without-dividend index value (P) at the end of quarter t. Fama and French (1989) employ the value-weighted index in deriving the dividend yield. Yet, Jensen, Mercer, and Johnson (1996) showed that there is not much different in deriving the dividend yield by using value-weighted and equal-weighted indexes. DEF represents default premium. The default premium also follows the measurement of Jensen, Mercer, and Johnson (1996). It is the difference between the quarterly average of daily rates on the Baa corporate bond and the ten-year Treasury bond from the Federal Reserve

Statistical Release H.15, Selected Interest Rates. DIR is the dummy variables of Federal Reserve discount-rate changes. Waud (1970), Smirlock and Yawitz (1985), Pearce and Roley (1985), and Cook and Hahn (1988) showed that Federal Reserve discount-rate changes have an impact on financial markets. Thus, a dummy variable is employed to represent the direction of Federal Reserve discount-rate changes (Jensen, Mercer, and Johnson (1996)). When the change of the rate is positive, the dummy variable is one. Otherwise, it is zero. FFP is the federal funds premium, the difference between the federal funds rate and the three-month Treasury-bill rate. Bernanke and Blinder (1992) found that the federal funds premium could be regarded as an indicator of monetary policy developments. BCP shows the number of commercial banks per capital and is used as an indicator of the competitiveness of the banking environment. SEASON is the dummy variables for controlling the seasonal effect. Q1=1 represents the first quarter (January – March), Q2=1 represents the second quarter (April – June), and Q3=1 is the third quarter (July – September. ΔGDP and ΔUNEMP are the change of gross domestic production and the change of the unemployment rate respectively.

ΔLEAD is the percentage change of the leading economic indicator.[42] The components of those composite indexes, such as leading, coincident, and lagging

---

[42] The components of the index of leading indicators are the followings: average weekly hours of production workers in manaufacturing, average weekly initial claims for unemployment insurance, new orders for consumer goods and materials (in 1987 dollars), vendor performance index (percent of companies reporting slower deliveries), contracts and orders, plant and equipment (1987 dollars), building

indicators, are shown in Table 33. Fama and French (1989) and Chauvet and Potter (2000) found evidence of significant state dependence in the conditional distribution of stock returns. Chauvet and Potter (2000) also showed a time-varying relationship between risk and return around business cycle turning points. Lynge (1981), Cornell (1983), and Pearce and Roley (1983) found that the monetary policy as measured by money supply announcement affected the financial market. Moreover, Friedman and Schwartz (1963), Sims (1972), and Christiano and Lyungqvist (1988) showed that business conditions have a linkage with the monetary aggregates. According to Figure 11, there is only one period of recession that is the faded area in Figure 11 between the third quarter of 1989 and the first quarter of 1990. Because money supply M2 is one of the components in leading indicator, the percentage change of the leading indicator is regarded as the proxy of the business cycles and the monetary policy condition.

FIRREA, FDICIA, and RNIBBEA are the dummy variables that represent the banking regulatory policies. FIRREA is the dummy variable to control the effect of the Federal Institutions Reform, Recovery, and Enforcement Act (FIRREA) of 1989, which was signed by President Bush on August 9, 1989. The dummy variable is 1 at the third quarter of 1989 and the dummy variable of the other periods is 0. FDICIA is the dummy

---

permits index (new private housing units), change in unfilled orders (durable goods in 1987 dollars), percentage change in sensitive material prices, stock price index (Standard and Poors 500), money supply (M2 in 1987 dollars), and index of Comsumer expectations (from the University of Michigan). The source of the information is from Auerbach and Kotlikoff, 1995.

variable for Federal Deposit Insurance Corporation Improvement Act (FDICIA) of 1991, which was signed by President Bush into law on December 20, 1991[43]. Thus, we define the dummy variable FDICIA as 1 at the fourth quarter of 1991 and the others are 0. RNIBBEA represents the dummy variable for the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994, enacted in September 1994. Therefore, RNIBBEA of the third quarter of 1994 is 1 and that of others periods is 0.

The model will be estimated for all commercial banks and for sub sets of commercial banks based upon their size. Also, due to potential multi-collinearity problems, various sub-sets of the independent variables will be examined separately.

Furthermore, according to the results of Gilbert (1997, 2000), competition from the entrance of large banks should compel small banks in the rural areas to operate more efficiently. This means that large banks with more resources are likely to expand into rural area leading to greater competition and efficiency. If the assumption is true, the average efficiency of the banking industry should increase through time when more large banks intrude into the rural market. From most bank efficiency studies, economies of scale do exist in the banking industry. Thus, large banks may be leading change in the efficiency of smaller banks. On the other hand, because of the competitiveness in the rural market, small banks operate more cost efficiently than large banks. In order to be

---

[43] Carow and Larsen Jr. (1997) provided the detail information of the passage of FDICIA in section II.

more competitive in the rural market, large banks increase their cost significantly after entering the market. Thus, the lead and lag relationship of the efficiency change of large and small banks is ambiguous. We also examine the lead and lag relationship of the average efficiency change of large and small banks. The model is tested as the following:

$$\Delta XEFF_{St} = b_1 \Delta XEFF_{St-1} + b_2 \Delta XEFF_{St-2} + \cdots\cdots + b_n \Delta XEFF_{St-n} + b_{n+1} \Delta XEFF_{Lt+1} + b_{n+2} \Delta XEFF_{Lt} + b_{n+3} \Delta XEFF_{Lt-1} + e_{it}, \tag{23}$$

where S and L represent small and large banks respectively. The design of the small and large banks is as following. Based on the distribution of banks size in Table 34 Panel A and B, banks with total assets equal to or more than $3 billion are defined as large banks. The rest of banks are regarded as small banks. Since, economies of scale do exist in the banking industry, those gigantic banks should operate most efficiently among the industry. Thus, the quarterly average change of large bank efficiency might be expected to lead the quarterly average change of small bank efficiency.

4.5 Results

Table 35 shows the results of the model on equation (22). The results show that the proxies for market conditions, business cycles, and macroeconomic conditions have higher explanatory power for banks between 50 million and 200 million dollars in total assets. Large banks are less dependent on the macroeconomic and market conditions.

Large banks are more independent on those factors because of their more diversified portfolios.

The results shown in Table 35 also indicate that the percentage change of banks size has significant negative impact on the percentage change of bank efficiency. This result is contradictory to previous studies. However, if the regression model is split into different size categories, we can find the percentage change of bank size has significantly positive impact on the change of bank efficiency when bank size is larger than 400 million dollars in total assets. As to the proxy of the market conditions, in general, market returns have significant negative impact on the bank efficiency change. The bull/bear market conditions positively affect the efficiency change of banks. Moreover, the percentage changes of gross domestic production, unemployment rate, and leading indicator all have significant results. Especially strong is the percentage change of leading indicator when negatively affects the efficiency changes of banks. This might be interpreted that banks should operate more efficiently when the economy is going down, otherwise, banks with lower efficiency might go bankruptcy.

Regulation in the banking industry plays an important role in bank efficiency change. The Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA) does not affect the change bank efficiency. However, the Federal Deposit Insurance Corporation Improvement Act (FDICIA) and Riegle-Neal Interstate Banking and Branching Efficiency Act (RNIBBEA) have significantly positive and negative impacts on bank efficiency change, respectively. Establishment of risk-based capital premiums in FDICIA improved the efficiency of the banking industry. However, RNIBBEA has a significant negative influence on the bank efficiency change. Banks with total assets more than $50 million are neutral to the passage of the act for the interstate branching. Smaller banks with less than $50 million in total assets are negatively affected by the passage of the law.

Table 36 and Table 37 show the simple statistics of X-efficiency for large and small bank.[44] In generally, there are less than 200 valid large bank observations through the examination periods, from 1988 to 1997. The number of large banks is increasing during the 10-year examination periods. The number of small banks with less than $3 billion dollars in total assets is much more than that of large banks. Yet, the number of small banks is decreasing through the examination periods. On average, large banks outperform small banks in terms of X-efficiency. The simple statistics of the percentage change of large and small bank efficiencies are also shown in Table 38 and Table 39. Autocorrelation is also examined for the time series of large and small bank efficiency in Table 40 and Table 41 respectively. The results show that the bank efficiencies of both large and small banks are autocorrelated up to six lags. The time series of large and small bank efficiency both are not stationary. Percentage of changes of both large and small bank efficiencies make both time series stationary. The results are shown in Table 42 and Table 43.

Since the time series data of percentage changes of large and small bank efficiency are stationary, lead or lag relationship between large and small bank efficiency change is examined. As to the hypotheses based on the assumption in the previous section, the efficiency change of large banks may lead that of small banks because of the competitiveness of the local financial market. However, the results in Table 44 show that this is not the case. The results show that efficiency changes of large and small banks do not have lead and lag relationships. Efficiencies of large and small banks change simultaneously. The percentage efficiency change of large banks is positively correlated to that of small banks. When large bank efficiency increases by 1%, small bank efficiency increases by 0.83%. On the other hand, small bank efficiency decreases by 0.83% when large bank efficiency declines by 1%. Thus, the efficiency change of large banks is more volatile than that of small banks. Overall, lead and lag relationships between large and small bank efficiency change do not exist. Both efficiencies of large and small bank move closely together.

[44] In this essay, large banks are defined as the one with equal to or more than $3 billion dollars in total assets. Small banks are the ones with less than $3 billion dollars in total assets.

4.6 Conclusions

Macroeconomic conditions do affect bank efficiency. Large banks are less affected by those economic factors because of the diversification of their portfolios. Seasonal effects also exist in bank efficiency changes. The results show that the second quarter has a negative and significant impact on bank efficiency change. Moreover, regulation in the banking industry is an important factor. The passage of FDICIA improves overall bank efficiency significantly.

Lead or lag relationship between large and small bank efficiency changes are also examined in this essay. Lead and lag relationships do not exist. The efficiency change of large and small banks is simultaneous. The results support the argument of Gilbert (1997) that the entrance of large bank into the local financial market improves the efficiency of the banking industry.

TABLE 31. MAJOR BANKING LEGISLATION IN THE UNITED STATES FROM 1988 TO 1997

Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA) of 1989

- Provided funds to resolve Savings and Loans (S&Ls) failure
- Eliminated the Federal Savings and Loans Insurance Corporation (FSLIC) and the Federal Home Loan Bank Board
- Created a new insurance fund (SAIF) under the management of the Federal Deposit Insurance Corporation (FDIC)
- Created the Office of Thrift Supervision (OTS) to regulate thrifts
- Created the Resolution Trust Corporation (RTC) to resolve insolvent thrifts
- Raised deposit insurance premiums
- Re-imposed restriction on Savings and Loans (S&Ls) activities

Federal Deposit Insurance Corporation Improvement Act (FDICIA) of 1991

- Re-capitalized the Federal Deposit Insurance Corporation (FDIC)
- Limited brokered deposits and the too-big-to-fail policy
- Set provisions for prompt corrective action (PCA), requiring mandatory interventions by regulators whenever a bank's capital falls
- Instructed the FDIC to establish risk-based premiums beginning in 1993
- Increased examinations, capital requirements, and reporting requirements
- Included the Foreign Bank Supervision Enhancement Act (FBSEA), which strengthened the Fed's authority to supervise foreign banks

Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994

- Permited banks holding companies to acquire banks in other states, starting September 1995
- Invalidated the laws of states that only allow interstate banking on a regional or reciprocal basis
- Beginning June 1997, bank holding companies was permitted to convert out-of-state subsidiary banks into branches of a single interstate bank
- Newly chartered branches were also permitted interstate if allowed by state law

* This information comes from Mishkin and Eakins (1998) and Saunders (1997)

TABLE 32. STATISTICS OF COMMERCIAL BANKS' X-EFFICIENCY

Number (N), mean (Mean), standard deviation (STD), minimum (Minimum), and maximum (Maximum) of all available commercial banks' X-efficiency in each period

Quarter/Year	N	Mean	STD	Minimum	Maximum
01/88	13493	0.9615389	0.0164629	0.9342307	1
02/88	13362	0.962879	0.0154328	0.9386537	1
03/88	13188	0.9653512	0.0142411	0.9441017	1
04/88	13071	0.9650262	0.0140527	0.9448373	1
01/89	12951	0.9702176	0.0120363	0.9534684	1
02/89	12901	0.969858	0.0119853	0.9538302	1
03/89	12778	0.9698037	0.0119138	0.9539253	1
04/89	12658	0.9664573	0.0128582	0.9496647	1
01/90	12547	0.9716948	0.011123	0.9565151	1
02/90	12456	0.971914	0.0109893	0.9572652	1
03/90	12362	0.9712227	0.0111101	0.9565828	1
04/90	12298	0.9705493	0.011386	0.955826	1
01/91	12205	0.9704031	0.0114006	0.9555581	1
02/91	12108	0.9672958	0.0125561	0.950956	1
03/91	12025	0.9684136	0.0121872	0.9528333	1
04/91	11872	0.9689972	0.0121807	0.9539456	1
01/92	11759	0.9623393	0.0144966	0.9449686	1
02/92	11638	0.9620402	0.0146812	0.9450204	1
03/92	11545	0.9610776	0.0150112	0.9439562	1
04/92	11424	0.9556204	0.0173887	0.9351169	1
01/93	11290	0.9531283	0.0177285	0.9337138	1
02/93	11161	0.948415	0.0194748	0.9275312	1
03/93	11047	0.9517172	0.0186091	0.93076	1
04/93	10933	0.9530229	0.0174107	0.9350429	1
01/94	10816	0.9563527	0.0157603	0.9403875	1
02/94	10694	0.9561427	0.0157536	0.9401388	1
03/94	10566	0.9559631	0.0159887	0.9390213	1
04/94	10424	0.9564464	0.0156869	0.9402391	1
01/95	10212	0.958814	0.0145525	0.943151	1
02/95	10142	0.9595763	0.0145391	0.9436393	1
03/95	10025	0.9602	0.0143501	0.9447016	1
04/95	9914	0.9586622	0.01486	0.9423382	1
01/96	9807	0.9615499	0.0138218	0.9451512	1
02/96	9660	0.9598226	0.0144524	0.9420214	1
03/96	9556	0.9468016	0.0203983	0.9169477	1
04/96	9498	0.9574082	0.0155628	0.9380668	1
01/97	9417	0.9587427	0.0150062	0.9401945	1
02/97	9266	0.9559556	0.015883	0.9371955	1
03/97	9177	0.9540928	0.0161803	0.9353275	1
04/97	9101	0.9526131	0.016795	0.9331643	1

TABLE 33. COMPONENTS OF THE COMPOSITE INDEXES

The composite indexes of leading, coincident, and lagging indicators are summary statistics for the U.S. economy. They are constructed by averaging their individual components in order to smooth out a good part of the volatility of the individual series. Historically, the cyclical turning points in the leading index have occurred before those in aggregate economic activity, cyclical turning points in the coincident index have occurred at about the same time as those in aggregate economic activity, and cyclical turning points in the lagging index generally have occurred after those in aggregate economic activity.

	Standardization Factor
Leading Index	
Average weekly hours, manufacturing	0.1899
Average weekly initial claims for unemployment insurance	0.024
Manufacturers' new orders, consumer goods and materials	0.0489
Vendor performance, slower deliveries diffusion index	0.0271
Manufacturers' new orders, non-defense capital goods	0.0125
Building permits, new private housing units	0.0184
Stock prices, 500 common stocks	0.0304
Money supply, M2	0.3034
Interest rate spread, 10-year Treasury bonds less federal funds	0.3274
Index of consumer expectations	0.018
Coincident Index	
Employees on nonagricultural payrolls	0.4822
Personal income less transfer payments	0.2795
Industrial production	0.1292
Manufacturing and trade sales	0.1091
Lagging Index	
Average duration of unemployment	0.0371
Inventories to sales ratio, manufacturing and trade	0.1224
Labor cost per unit of output, manufacturing	0.0615
Average prime rate	0.2445
Commercial and industrial loans	0.1275
Consumer installment credit to personal income ratio	0.2204
Consumer price index for services	0.1866

Source: http://www.tcb-indicators.org/lei/component_description.htm

TABLE 34. DISTRIBUTION OF BANKS BASED ON BANK'S SIZE

The table shows the number of banks (Feq) and relative percentage (%) in the various size range in the first quarter of 1988 (Panel A) and the first quarter of 1997 (Panel B). Size is measured using total assets. M and B represent million dollars and billion dollars respectively.

PANEL A. DISTRIBUTION OF ALL BANKS BASED ON SIZE IN THE FIRST QURTER OF 1988

Size	Freq	%	Size	Freq	%	Size	Freq	%	Size	Freq	%
<10M	970	7.19	790-810M	4	0.03	1.59-1.61B	2	0.01	2.39-2.41B	1	0.01
10-30M	4374	32.41	810-830M	5	0.04	1.61-1.63B	1	0.01	2.41-2.43B	1	0.01
30-50M	2600	19.27	830-850M	6	0.04	1.63-1.65B	1	0.01	2.43-2.45B	0	0
50-70M	1592	11.8	850-870M	1	0.01	1.65-1.67B	2	0.01	2.45-2.47B	1	0.01
70-90M	873	6.47	870-890M	10	0.07	1.67-1.69B	1	0.01	2.47-2.49B	0	0
90-110M	600	4.45	890-910M	8	0.06	1.69-1.71B	4	0.03	2.49-2.51B	2	0.01
110-130M	417	3.09	910-930M	2	0.01	1.71-1.73B	2	0.01	2.51-2.53B	0	0
130-150M	306	2.27	930-950M	6	0.04	1.73-1.75B	1	0.01	2.53-2.55B	1	0.01
150-170M	217	1.61	950-970M	9	0.07	1.75-1.77B	2	0.01	2.55-2.57B	0	0
170-190M	153	1.13	970-990M	5	0.04	1.77-1.79B	0	0	2.57-2.59B	0	0
190-210M	138	1.02	990-1010M	4	0.03	1.79-1.81B	0	0	2.59-2.61B	2	0.01
210-230M	121	0.9	1.01-1.03B	6	0.04	1.81-1.83B	1	0.01	2.61-2.63B	0	0
230-250M	85	0.63	1.03-1.05B	3	0.02	1.83-1.85B	3	0.02	2.63-2.65B	0	0
250-270M	65	0.48	1.05-1.07B	10	0.07	1.85-1.87B	7	0.05	2.65-2.67B	2	0.01
270-290M	58	0.43	1.07-1.09B	2	0.01	1.87-1.89B	6	0.04	2.67-2.69B	0	0
290-310M	51	0.38	1.09-1.11B	6	0.04	1.89-1.91B	0	0	2.69-2.71B	0	0
310-330M	56	0.41	1.11-1.13B	6	0.04	1.91-1.93B	3	0.02	2.71-2.73B	4	0.03
330-350M	37	0.27	1.13-1.15B	4	0.03	1.93-1.95B	3	0.02	2.73-2.75B	2	0.01
350-370M	37	0.27	1.15-1.17B	4	0.03	1.95-1.97B	1	0.01	2.75-2.77B	3	0.02
370-390M	35	0.26	1.17-1.19B	5	0.04	1.97-1.99B	0	0	2.77-2.79B	1	0.01
390-410M	35	0.26	1.19-1.21B	4	0.03	1.99-2.01B	0	0	2.79-2.81B	0	0
410-430M	22	0.16	1.21-1.23B	2	0.01	2.01-2.03B	1	0.01	2.81-2.83B	1	0.01
430-450M	31	0.23	1.23-1.25B	7	0.05	2.03-2.05B	1	0.01	2.83-2.85B	0	0
450-470M	24	0.18	1.25-1.27B	5	0.04	2.05-2.07B	3	0.02	2.85-2.87B	2	0.01
470-490M	28	0.21	1.27-1.29B	2	0.01	2.07-2.09B	2	0.01	2.87-2.89B	2	0.01
490-510M	14	0.1	1.29-1.31B	1	0.01	2.09-2.11B	1	0.01	2.89-2.91B	1	0.01
510-530M	8	0.06	1.31-1.33B	2	0.01	2.11-2.13B	0	0	2.91-2.93B	2	0.01
530-550M	17	0.13	1.33-1.35B	4	0.03	2.13-2.15B	3	0.02	2.93-2.95B	1	0.01
550-570M	12	0.09	1.35-1.37B	4	0.03	2.15-2.17B	1	0.01	2.95-2.97B	0	0
570-590M	17	0.13	1.37-1.39B	4	0.03	2.17-2.19B	0	0	2.97-2.99B	1	0.01
590-610M	13	0.1	1.39-1.41B	4	0.03	2.19-2.21B	1	0.01	>2.99B	148	1.1
610-630M	10	0.07	1.41-1.43B	3	0.02	2.21-2.23B	1	0.01			
630-650M	14	0.1	1.43-1.45B	3	0.02	2.23-2.25B	2	0.01			
650-670M	8	0.06	1.45-1.47B	2	0.01	2.25-2.27B	1	0.01			
670-690M	11	0.08	1.47-1.49B	2	0.01	2.27-2.29B	1	0.01			
690-710M	7	0.05	1.49-1.51B	2	0.01	2.29-2.31B	3	0.02			
710-730M	11	0.08	1.51-1.53B	4	0.03	2.31-2.33B	1	0.01			
730-750M	2	0.01	1.53-1.55B	4	0.03	2.33-2.35B	1	0.01			
750-770M	6	0.04	1.55-1.57B	2	0.01	2.35-2.37B	1	0.01			
770-790M	5	0.04	1.57-1.59B	4	0.03	2.37-2.39B	1	0.01			

PANEL B. THE DISTRIBUTION OF BANKS BASED ON SIZE (TOTAL ASSETS)
The table shows the number of banks (Feq) in the size range in the first quarter of 1997. M and B represent million dollars and billion dollars respectively. Percent shows the proportion of all sample size.

Size	Freq	%	Size	Freq	%	Size	Freq	%	Size	Freq	%
<10M	236	2.51	790-810M	17	0.18	1.59-1.61B	2	0.02	2.39-2.41B	0	0
10-30M	1778	18.88	810-830M	9	0.1	1.61-1.63B	1	0.01	2.41-2.43B	1	0.01
30-50M	1724	18.31	830-850M	11	0.12	1.63-1.65B	2	0.02	2.43-2.45B	2	0.02
50-70M	1195	12.69	850-870M	12	0.13	1.65-1.67B	3	0.03	2.45-2.47B	0	0
70-90M	854	9.07	870-890M	8	0.08	1.67-1.69B	2	0.02	2.47-2.49B	1	0.01
90-110M	634	6.73	890-910M	5	0.05	1.69-1.71B	2	0.02	2.49-2.51B	3	0.03
110-130M	472	5.01	910-930M	5	0.05	1.71-1.73B	3	0.03	2.51-2.53B	2	0.02
130-150M	353	3.75	930-950M	8	0.08	1.73-1.75B	5	0.05	2.53-2.55B	2	0.02
150-170M	246	2.61	950-970M	4	0.04	1.75-1.77B	1	0.01	2.55-2.57B	1	0.01
170-190M	208	2.21	970-990M	2	0.02	1.77-1.79B	1	0.01	2.57-2.59B	0	0
190-210M	157	1.67	990-1010M	2	0.02	1.79-1.81B	2	0.02	2.59-2.61B	1	0.01
210-230M	140	1.49	1.01-1.03B	9	0.1	1.81-1.83B	0	0	2.61-2.63B	1	0.01
230-250M	124	1.32	1.03-1.05B	2	0.02	1.83-1.85B	3	0.03	2.63-2.65B	1	0.01
250-270M	107	1.14	1.05-1.07B	4	0.04	1.85-1.87B	0	0	2.65-2.67B	0	0
270-290M	75	0.8	1.07-1.09B	11	0.12	1.87-1.89B	3	0.03	2.67-2.69B	2	0.02
290-310M	57	0.61	1.09-1.11B	8	0.08	1.89-1.91B	0	0	2.69-2.71B	0	0
310-330M	62	0.66	1.11-1.13B	5	0.05	1.91-1.93B	2	0.02	2.71-2.73B	3	0.03
330-350M	55	0.58	1.13-1.15B	5	0.05	1.93-1.95B	1	0.01	2.73-2.75B	1	0.01
350-370M	37	0.39	1.15-1.17B	5	0.05	1.95-1.97B	0	0	2.75-2.77B	1	0.01
370-390M	42	0.45	1.17-1.19B	6	0.06	1.97-1.99B	0	0	2.77-2.79B	3	0.03
390-410M	28	0.3	1.19-1.21B	7	0.07	1.99-2.01B	1	0.01	2.79-2.81B	1	0.01
410-430M	31	0.33	1.21-1.23B	3	0.03	2.01-2.03B	3	0.03	2.81-2.83B	0	0
430-450M	44	0.47	1.23-1.25B	6	0.06	2.03-2.05B	3	0.03	2.83-2.85B	0	0
450-470M	25	0.27	1.25-1.27B	5	0.05	2.05-2.07B	0	0	2.85-2.87B	0	0
470-490M	35	0.37	1.27-1.29B	2	0.02	2.07-2.09B	1	0.01	2.87-2.89B	0	0
490-510M	23	0.24	1.29-1.31B	2	0.02	2.09-2.11B	0	0	2.89-2.91B	0	0
510-530M	29	0.31	1.31-1.33B	2	0.02	2.11-2.13B	4	0.04	2.91-2.93B	1	0.01
530-550M	31	0.33	1.33-1.35B	8	0.08	2.13-2.15B	2	0.02	2.93-2.95B	1	0.01
550-570M	17	0.18	1.35-1.37B	4	0.04	2.15-2.17B	3	0.03	2.95-2.97B	0	0
570-590M	12	0.13	1.37-1.39B	2	0.02	2.17-2.19B	3	0.03	2.97-2.99B	3	0.03
590-610M	20	0.21	1.39-1.41B	3	0.03	2.19-2.21B	1	0.01	>2.99B	190	2.02
610-630M	12	0.13	1.41-1.43B	5	0.05	2.21-2.23B	2	0.02			
630-650M	9	0.1	1.43-1.45B	3	0.03	2.23-2.25B	2	0.02			
650-670M	11	0.12	1.45-1.47B	1	0.01	2.25-2.27B	0	0			
670-690M	11	0.12	1.47-1.49B	0	0	2.27-2.29B	1	0.01			
690-710M	2	0.02	1.49-1.51B	3	0.03	2.29-2.31B	0	0			
710-730M	6	0.06	1.51-1.53B	4	0.04	2.31-2.33B	1	0.01			
730-750M	6	0.06	1.53-1.55B	1	0.01	2.33-2.35B	0	0			
750-770M	13	0.14	1.55-1.57B	2	0.02	2.35-2.37B	2	0.02			
770-790M	11	0.12	1.57-1.59B	2	0.02	2.37-2.39B	0	0			

TABLE 35. REGRESSION MODEL RESULTS

This table contains the results of the estimation of the regression model for bank efficiency changes by size categories. The variables used in the model are the percentage change of bank size, percentage change of total loans, market return based on CRSP equal weighted index, bull/bear market dummy variable, dividend yield, default premium, dummy variable for federal discount-rate change, federal funds premium, banks per capita at the county level, quarter dummy variables (q1 q2 q3), percentage change of gross domestic production, percentage change of unemployment rate, percentage change of leading indicator, and dummy variables of important deregulation acts, respectively.

	ALL Banks	<20M	20M-50M	50M-100M	100M-200M	200M-300M	300M-400M	400M-500M	500M-1000M	1000M-2000M	>3000M
Adjusted R^2	0.0774	0.0712	0.0859	0.0982	0.0945	0.0882	0.0802	0.084	0.062	0.0349	0.0419
Intercept	-0.01501***	-0.01867***	-0.01697***	-0.01432***	-0.01191***	-0.00924***	-0.01171***	-0.00885***	-0.01047***	-0.01098***	-0.00885***
ΔSize	-0.00055894***	-0.00504***	-0.0033***	-0.00017761	-0.00088213***	-0.00075138***	-0.00091457***	0.00088501**	0.00010227	0.00020199	0.00072683***
ΔTL	0.00000332***	0.00002561***	0.0000009961329	-0.00008692***	-0.00001028	0.00000174	-0.00022019***	-0.00014922	0.00006292	-0.00000674	-0.00011546*
MR	-0.00564***	-0.00639***	-0.00752***	-0.00571***	-0.00364***	-0.00261***	-0.00606***	-0.00297	-0.00334**	-0.00312	0.00483**
BB	0.00408***	0.00431***	0.00424***	0.00406***	0.00397***	0.00361***	0.00384***	0.00418***	0.00392***	0.00352***	0.00305***
DP	1.26744***	2.05376***	1.66769***	1.11366***	0.62368***	0.38665***	0.48246**	-0.0231	0.47467*	0.68709*	0.50941
DEF	-0.00938	-0.04549**	0.0029	0.01257	-0.00087903	-0.08631**	0.05403	-0.02894	-0.08709	-0.0516	-0.15452*
DIR	-0.00014495***	-0.00044588***	-0.00014691**	-0.00013565*	0.00005915	0.00003329	0.0000969	0.00074372*	-0.00003701	-0.00019995	0.00010557
FFP	0.08767***	0.03782***	0.07409***	0.10793***	0.12017***	0.08537***	0.13358***	0.09044**	0.0819**	0.1734***	0.05276
BPC	0.31135***	0.15321	0.1139	0.02093	-0.04622	1.31985	0.20273	-2.56383	8.1987**	-1.22246	1.20988
q1	0.00204***	0.00207***	0.00263***	0.00209***	0.00134***	0.00113***	0.00185***	0.0012***	0.00138***	0.00102**	-0.00112**
q2	-0.00054744***	0.00018554*	0.00004093	-0.00072158***	-0.00141***	-0.00178***	-0.0015***	-0.00243***	-0.00169***	-0.0014***	-0.00207***
q3	0.0019***	0.00296***	0.0024***	0.00169***	0.00104***	0.0009558***	0.00082544***	0.0000232	0.00122***	0.0015***	-0.00007945
ΔGDP	0.49055***	0.53968***	0.45901***	0.46316***	0.49461***	0.51761***	0.47615***	0.57331***	0.56256***	0.49822***	0.63003***
ΔUNEMP	0.03982***	0.02904***	0.03429***	0.04058***	0.04896***	0.05493***	0.0465***	0.0687***	0.05486***	0.04238***	0.07045***
ΔLEAD	-0.29672***	-0.31543***	-0.26379***	-0.28501***	-0.31058***	-0.3485***	-0.27971***	-0.33879***	-0.37976***	-0.24304***	-0.40605***
FIRREA	-0.00003819	-0.00049575**	0.00005346	-0.00005926	0.00013246	0.00042532	0.00029759	0.00153*	-0.00003406	-0.0013	-0.00051812
FDICIA	0.00206***	0.00281***	0.0024***	0.00188***	0.00152***	0.00136***	0.00128***	0.00067231	0.00142**	0.00193*	0.00117
RNIBBEA	-0.00041174***	-0.00202***	-0.00068227***	0.0000072	0.00018953	0.00025646	0.00015102	-0.00034234	-0.00006125	0.00035237	0.00067799

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively.

TABLE 36. SUMMARY STATISTICS OF LARGE BANK EFFICIENCY

Large banks have more than $3 billion in total assets. Max and Min mean the maximum and minimum X-efficiency among the large banks. Mean is the average of X-efficiency of large banks. N represents the sample size and STD is the standard deviation of X-efficiency of the samples.

Quarter/Year	MAX	MEAN	MIN	N	STD
0188	1	0.967201	0.934231	148	0.023169957
0288	1	0.967528	0.938654	152	0.018821537
0388	1	0.970177	0.944102	159	0.016415619
0488	1	0.96978	0.944837	164	0.01579249
0189	1	0.975412	0.953468	161	0.013110313
0289	1	0.977161	0.95383	165	0.012703865
0389	1	0.976003	0.953925	165	0.012367783
0489	1	0.974055	0.949665	169	0.012506418
0190	1	0.977454	0.956515	165	0.010857815
0290	1	0.978436	0.957265	166	0.01073283
0390	1	0.978401	0.956583	173	0.011035825
0490	1	0.978751	0.955826	172	0.011040612
0191	1	0.981431	0.955558	168	0.013084662
0291	1	0.980596	0.950956	173	0.015656986
0391	1	0.982063	0.952833	175	0.013170081
0491	1	0.984602	0.953946	179	0.011959936
0192	1	0.979612	0.944969	181	0.013644163
0292	1	0.978866	0.94502	179	0.014214949
0392	1	0.978614	0.943956	177	0.014353996
0492	1	0.976301	0.935117	178	0.017478277
0193	1	0.96928	0.933714	174	0.019118399
0293	1	0.965417	0.927531	180	0.022456088
0393	1	0.97019	0.93076	181	0.02031283
0493	1	0.970881	0.935043	184	0.020071359
0194	1	0.972529	0.940388	188	0.017346073
0294	1	0.972265	0.940139	188	0.018996405
0394	1	0.973117	0.939021	187	0.018453163
0494	1	0.972554	0.940239	195	0.018404661
0195	1	0.974341	0.943151	191	0.019236062
0295	1	0.974897	0.943639	197	0.019761723
0395	1	0.976677	0.944702	198	0.017596232
0495	1	0.976955	0.942338	201	0.017971244
0196	1	0.975804	0.945151	199	0.017089791
0296	1	0.976058	0.942021	191	0.017074016
0396	1	0.959155	0.916948	189	0.031922537
0496	1	0.970853	0.938067	189	0.016474249
0197	1	0.974965	0.940195	190	0.017385715
0297	1	0.975609	0.937196	180	0.018908579
0397	1	0.971433	0.935327	174	0.019382833
0497	1	0.968595	0.933164	170	0.020281795

TABLE 37. SIMPLE STATISTICS OF SMALL BANK EFFICIENCY

Small banks have less than $3 billion in total assets. Max and Min mean the maximum and minimum X-efficiency among the samples of small banks respectively. Mean is the average of X-efficiency of small banks. N represents the sample size and STD is the standard deviation of X-efficiency of the samples.

Quarter/Year	MAX	MEAN	MIN	N	STD
0188	1	0.961476	0.934231	13345	0.016363
0288	1	0.962826	0.938654	13210	0.015382
0388	1	0.965292	0.944102	13029	0.014203
0488	1	0.964966	0.944837	12907	0.01402
0189	1	0.970152	0.953468	12790	0.012008
0289	1	0.969763	0.95383	12736	0.011947
0389	1	0.969723	0.953925	12613	0.011887
0489	1	0.966354	0.949665	12489	0.012833
0190	1	0.971618	0.956515	12382	0.011107
0290	1	0.971826	0.957265	12290	0.010967
0390	1	0.971121	0.956583	12189	0.011078
0490	1	0.970433	0.955826	12126	0.011349
0191	1	0.970249	0.955558	12037	0.0113
0291	1	0.967103	0.950956	11935	0.012402
0391	1	0.968212	0.952833	11850	0.012057
0491	1	0.968758	0.953946	11693	0.012028
0192	1	0.962069	0.944969	11578	0.014346
0292	1	0.961777	0.94502	11459	0.014535
0392	1	0.960805	0.943956	11368	0.014859
0492	1	0.955293	0.935117	11246	0.017189
0193	1	0.952876	0.933714	11116	0.017589
0293	1	0.948136	0.927531	10981	0.019299
0393	1	0.951409	0.93076	10866	0.018424
0493	1	0.952717	0.935043	10749	0.017202
0194	1	0.956067	0.940388	10628	0.015581
0294	1	0.955854	0.940139	10506	0.015539
0394	1	0.955654	0.939021	10379	0.015772
0494	1	0.956139	0.940239	10229	0.015469
0195	1	0.958518	0.943151	10021	0.014287
0295	1	0.959273	0.943639	9945	0.014253
0395	1	0.959868	0.944702	9827	0.014081
0495	1	0.958284	0.942338	9713	0.014549
0196	1	0.961255	0.945151	9608	0.01359
0296	1	0.959495	0.942021	9469	0.014206
0396	1	0.946552	0.916948	9367	0.020022
0496	1	0.957135	0.938067	9309	0.015424
0197	1	0.958409	0.940195	9227	0.014768
0297	1	0.955566	0.937196	9086	0.01557
0397	1	0.953758	0.935327	9003	0.015929
0497	1	0.952309	0.933164	8931	0.016574

TABLE 38. SUMMARY STATISTICS OF PERCENTAGE CHANGE OF LARGE BANK EFFICIENCY

Large banks have more than $3 billion in total assets. Max and Min mean the maximum and minimum of percentage change of X-efficiency among the samples of large banks respectively. Mean is the average percentage change of X-efficiency of large banks. N represents the sample size and STD is the standard deviation of percentage change of X-efficiency of the samples.

Quarter/Year	MAX	MEAN	MIN	N	STD
0288	0.070399	0.000795	-0.02188	152	0.012258
0388	0.041205	0.003172	-0.02093	158	0.008847
0488	0.020264	0.000151	-0.01705	164	0.004285
0189	0.045482	0.005751	-0.02418	160	0.010126
0289	0.01134	0.00184	-0.0075	165	0.003149
0389	0.007634	-0.00102	-0.01355	164	0.003074
0489	0.036569	-0.00194	-0.01846	169	0.006124
0190	0.031877	0.003392	-0.03679	165	0.006257
0290	0.008802	0.000938	-0.02088	166	0.003051
0390	0.01114	-1.6E-05	-0.00901	173	0.002824
0490	0.021711	0.000453	-0.01042	172	0.003303
0191	0.046215	0.002582	-0.02104	165	0.007908
0291	0.029607	-0.00049	-0.02431	173	0.007419
0391	0.023249	0.001235	-0.04717	174	0.006876
0491	0.024644	0.002979	-0.00742	179	0.003941
0192	0.031321	-0.00532	-0.02786	181	0.006891
0292	0.014931	-0.00019	-0.04976	179	0.005669
0392	0.011973	-0.00034	-0.01722	177	0.003603
0492	0.026136	-0.00236	-0.04365	177	0.008785
0193	0.044307	-0.00678	-0.03843	174	0.010168
0293	0.070992	-0.00356	-0.06234	180	0.010743
0393	0.058452	0.004538	-0.06924	181	0.014058
0493	0.039188	0.00116	-0.05716	183	0.01157
0194	0.06947	0.001382	-0.0287	188	0.011999
0294	0.016943	-0.00044	-0.02746	188	0.006783
0394	0.063673	0.000469	-0.06098	187	0.011271
0494	0.018177	0.000695	-0.02655	195	0.004648
0195	0.063559	0.00209	-0.04682	191	0.013406
0295	0.024138	0.000652	-0.03398	197	0.007061
0395	0.04761	0.001996	-0.02452	198	0.006948
0495	0.034209	0.000763	-0.0409	201	0.006596
0196	0.06119	-0.00089	-0.03686	199	0.010579
0296	0.035118	-0.00052	-0.05731	191	0.00813
0396	0.061547	-0.0173	-0.08305	189	0.033917
0496	0.0762	0.013598	-0.03735	189	0.027277
0197	0.066022	0.003988	-0.05981	189	0.014363
0297	0.024022	0.000228	-0.04053	178	0.005978
0397	0.008425	-0.00383	-0.05175	173	0.006829
0497	0.011948	-0.00239	-0.0273	170	0.005099

TABLE 39. SUMMARY STATISTICS OF PERCENTAGE CHANGE OF SMALL BANK EFFICIENCY

Small banks have less than $3 billion in total assets. Max and Min mean the maximum and minimum of percentage change of X-efficiency among the samples of small banks respectively. Mean is the average percentage change of X-efficiency of small banks. N represents the sample size and STD is the standard deviation of percentage change of X-efficiency of the samples.

Quarter/Year	MAX	MEAN	MIN	N	STD
0288	0.070399	0.001355	-0.06135	13147	0.00704
0388	0.065356	0.002508	-0.0559	12981	0.005319
0488	0.059208	-0.00048	-0.05516	12834	0.004534
0189	0.058383	0.005325	-0.04653	12736	0.008029
0289	0.048802	-0.00051	-0.04617	12669	0.003835
0389	0.048405	-0.00011	-0.04607	12571	0.003184
0489	0.0483	-0.00359	-0.05034	12444	0.004468
0190	0.053003	0.005404	-0.04348	12337	0.007145
0290	0.045462	0.00017	-0.04273	12241	0.003552
0390	0.044643	-0.00079	-0.04342	12143	0.002991
0490	0.045388	-0.00079	-0.04417	12073	0.003509
0191	0.046215	-0.00019	-0.04444	12010	0.006731
0291	0.046509	-0.00336	-0.04904	11890	0.00484
0391	0.051573	0.001093	-0.04717	11810	0.004013
0491	0.049502	0.000613	-0.04605	11670	0.003998
0192	0.048278	-0.00696	-0.05503	11556	0.007608
0292	0.058236	-0.00031	-0.05498	11445	0.004434
0392	0.058178	-0.00103	-0.05604	11354	0.003435
0492	0.059371	-0.00581	-0.06488	11205	0.007001
0193	0.069385	-0.00254	-0.06629	11100	0.010136
0293	0.070992	-0.00501	-0.07247	10961	0.006418
0393	0.078131	0.003487	-0.06924	10849	0.007172
0493	0.074391	0.001367	-0.05741	10727	0.007159
0194	0.06947	0.00354	-0.05961	10612	0.00891
0294	0.063391	-0.00024	-0.05986	10487	0.004791
0394	0.063673	-0.00023	-0.06098	10365	0.004906
0494	0.064939	0.000424	-0.05976	10208	0.005064
0195	0.063559	0.002503	-0.05685	9998	0.008569
0295	0.060276	0.000744	-0.05636	9909	0.004494
0395	0.059727	0.000596	-0.05303	9799	0.003516
0495	0.058535	-0.00177	-0.05766	9675	0.004253
0196	0.06119	0.003055	-0.05485	9576	0.007616
0296	0.058032	-0.00195	-0.05798	9431	0.004436
0396	0.061547	-0.01368	-0.08305	9318	0.013656
0496	0.090575	0.011164	-0.06193	9264	0.01154
0197	0.066022	0.001244	-0.05981	9176	0.010057
0297	0.06361	-0.0031	-0.0628	9030	0.005306
0397	0.067013	-0.00219	-0.06467	8944	0.003999
0497	0.069144	-0.00171	-0.06684	8872	0.005276

TABLE 40. TIME SERIES PROPERTIES OF LARGE BANK X-EFFICIENCY

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	2.46E-05	1	0
1	1.52E-05	0.6162	0.158114
2	9.08E-06	0.36877	0.209727
3	6.03E-06	0.24462	0.225355
4	4.83E-06	0.19593	0.231898
5	2.91E-06	0.11831	0.236
6	-1.27E-06	-0.05158	0.237478
7	-2.38E-06	-0.09667	0.237758
8	-5.11E-06	-0.20766	0.238739

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	27.68	6	0.0001	0.616	0.369	0.245	0.196	0.118	-0.052

TABLE 41. TIME SERIES PROPERTIES OF SMALL BANK X-EFFICIENCY

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	4.74E-05	1	0
1	3.99E-05	0.84026	0.158114
2	3.51E-05	0.7408	0.245564
3	3.24E-05	0.68226	0.296212
4	2.83E-05	0.59719	0.33319
5	2.32E-05	0.48889	0.358953
6	1.57E-05	0.332	0.375231
7	1.11E-05	0.23331	0.382504
8	6.76E-06	0.14261	0.386045

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	109.37	6	<.0001	0.840	0.741	0.682	0.597	0.489	0.332

TABLE 42. TIME SERIES PROPERTIES OF PERCENTAGE CHANGE OF LARGE BANK X-EFFICIENCY

	Autocorrelations		
Lag	Covariance	Correlation	Std Error
0	1.87E-05	1	0
1	-3.30E-06	-0.17654	0.160128
2	-2.27E-06	-0.12145	0.165044
3	-2.18E-06	-0.11675	0.167319
4	1.08E-06	0.05789	0.169395
5	1.33E-06	0.0711	0.169902
6	-9.25E-07	-0.04946	0.170663
7	6.89E-07	0.03685	0.17103
8	-9.06E-07	-0.04849	0.171234

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	3.06	6	0.8008	-0.177	-0.121	-0.117	0.058	0.071	-0.049

TABLE 43. TIME SERIES PROPERTIES OF PERCENTAGE CHANGE OF SMALL BANK X-EFFICIENCY

	Autocorrelations		
Lag	Covariance	Correlation	Std Error
0	1.5E-05	1	0
1	-3.02E-06	-0.20124	0.160128
2	-1.89E-06	-0.12593	0.166486
3	1.98E-06	0.13154	0.168911
4	7.40E-07	0.04931	0.171517
5	-1.23E-07	-0.00821	0.171881
6	-5.99E-08	-0.00399	0.171891
7	3.94E-08	0.00263	0.171893
8	-8.71E-07	-0.05801	0.171894

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	3.27	6	0.7739	-0.201	-0.126	0.132	0.049	-0.008	-0.004

TABLE 44. LEAD AND LAG RELATIONSHIPS IN SMALL AND LARGE BANKS' EFFICIENCY
The following are the results of the model shown in equation (2), as shown below.

$$\Delta XEFF_{St} = b_1 \Delta XEFF_{St-1} + b_2 \Delta XEFF_{St-2} + \cdots\cdots + b_n \Delta XEFF_{St-n} + b_{n+1} \Delta XEFF_{Lt+1}$$
$$+ b_{n+2} \Delta XEFF_{Lt} + b_{n+3} \Delta XEFF_{Lt-1} + e_{it},$$

Centered R**2	0.846063
R Bar **2	0.783089
Uncentered R**2	0.848949
T x R**2 27.166	
Mean of Dependent Variable	-0.000567214
Std Error of Dependent Variable	0.004169672
Standard Error of Estimate	0.001941970
Sum of Squared Residuals	0.0000829675
Regression F(9,22)	13.4351
Significance Level of F	0.00000049
Durbin-Watson Statistic	1.774582
Q(8-0)	1.838463
Significance Level of Q	0.98556986

Variable	Coefficient	Std Error	T-Stat
Constant	-0.000670925	0.000372671	-1.80031*
$\Delta XEFF_{St-1}$	-0.223822956	0.209539215	-1.06817
$\Delta XEFF_{St-2}$	0.010877243	0.096500168	0.11272
$\Delta XEFF_{St-3}$	0.075756928	0.095434712	0.79381
$\Delta XEFF_{St-4}$	-0.041279614	0.107031749	-0.38568
$\Delta XEFF_{St-5}$	-0.071924607	0.12520395	-0.57446
$\Delta XEFF_{St-6}$	0.096457309	0.126254933	0.76399
$\Delta XEFFL_{t+1}$	0.03494987	0.081420897	0.42925
$\Delta XEFF_{Lt}$	0.83011372	0.084579393	9.81461***
$\Delta XEFF_{Lt-1}$	0.140526845	0.186507327	0.75347

***, **, and * represent 1%, 5%, and 10% statistical significance levels respectively.

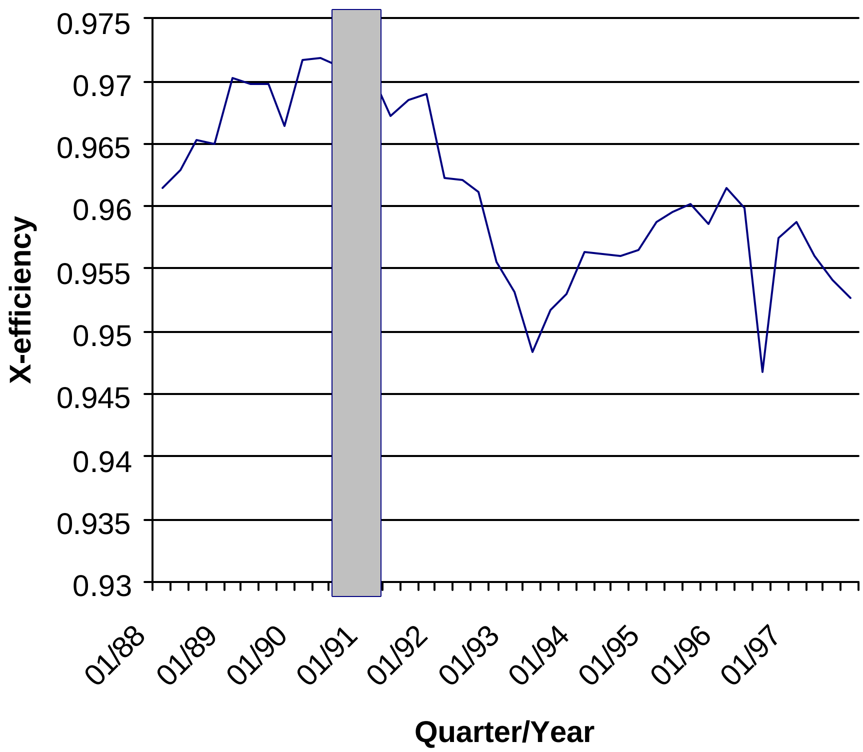

FIGURE 11. X-EFFICIENCY VERSUS BUSINESS CYCLES
This figure shows the movement of average X-efficiency of the banking industry accompanied with the business cycles. The faded area represent the period of recession during the sample period. Series 1 indicates the mean of X-efficiency of U.S. commercial banks in each sample quarter.

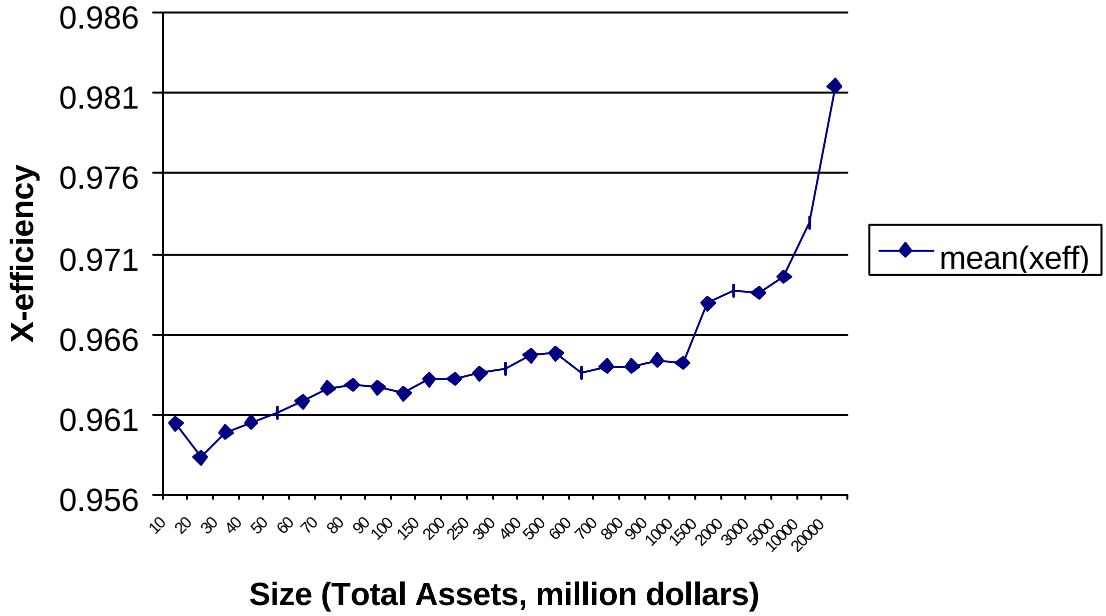

FIGURE 12. X-EFFICIENCY OF BANKS BASED ON DIFFERENT SIZE CATEGORIES
This figure shows the quarterly average X-efficiency of banks based on different size categories.

CHAPTER 5

AN ALTERNATIVE ESTIMATION OF X-EFFICIENCY IN BANKS

5.1 Abstract

Cross sectional regression analysis is the traditional estimation technique for X-efficiency. Time series properties of the data are not considered in the estimation of X-efficiency. Thus, autocorrelation may create bias for the estimation. In this essay, an alternative estimation, considering both cross section and time series properties of the data, is conducted. The estimation of the alternative approaches is applied to the empirical analyses done in the first two essays.

5.2 Introduction

Previous studies generally use the translog function equation to estimate X-efficiency in banks. Cross sectional regression methodology is used to calculate the residual and form the X-efficient frontier. The technique of seeming unrelated regression (SUR) is generally employed in those studies. However, total costs, outputs, and inputs of banks are time-varying might have autocorrelation during the testing periods. Moreover, the residuals of the translog function are also correlated with previous time periods. If the cost efficient frontier is formed in this approach, the frontier might be biased.

In this study, the problem of autocorrelation in the residuals is considered. Thus, cross-sectional and time series properties are considered jointly for the estimation of the translog function. A comparison of two different approaches will be conducted. We expect the alternative approach, which considers both cross section and time series variation, will form a better efficient frontier for the X-efficiency. An empirical analysis will be conducted to show the differences of the results between the new and old approaches. We re-examine the results found in the first two essays by utilizing the time-series, cross-sectional estimates of X-efficiency.

5.3 Literature Review

According to previous studies, there is lack of agreement among researches regarding a better frontier estimation approach. Berger and Humphrey (1997) documented a number of different possible approaches. The parametric approaches commit the mistake of imposing a particular functional form and associated behavioral assumptions that presuppose the shape of the frontier. The nonparametric studies impose less structure on the frontier but commit the mistake of not allowing for random error owing to luck, data problems, or other measurement error. If random error exists, measured efficiency may be confounded with these random deviations from the true efficient frontier. The conflict between the nonparametric and parametric approaches is important because the two types of methods tend to have different degrees of dispersion and rank the same financial institutions somewhat differently. Thus, Berger and Humphrey (1997) suggested that it would be more appropriate to add more flexibility into the parametric approaches and to introduce a degree of random error into the nonparametric approaches.

Bentson, Hanweck, and Humphrey (1982) first investigated scale economies in banking by using the translog function. Murray and White (1983) also applied the translog function examining scale and scope economies of British Columbia credit unions. They mentioned that the translog function is essentially a second-order Taylor series expansion in output quantities and input prices. The cost function should be linearly homogeneous in all input prices, concave in input prices, and increasing in the product of output and input price. Humphrey (1985) distinguished the difference between the production approach and the intermediation approach to bank behavior. Demand deposits, time and saving deposits, the variety of loans, and employment of capital, labor, and materials are regarded as the production of banks. The production approach treats those outputs and inputs as banks' production. The intermediation approach views banks as collectors of funds which are transformed into other products, like loans and other assets. Humphrey emphasized that the production approach provides better measurement of cost efficiency because operating costs of banks are the only concern of this approach. The overall costs of banking are the concern of the intermediation approach, which is appropriate for describing the problems related to the economic viability of banks. Berger, Hanweck, and Humphrey (1987) examined the competitive viability in the banking industry by using the intermediation approach. Ferrier and Lovell (1990) concluded that it is appropriate to employ production approach for the study of cost efficiency because cost efficiency only concern the operating costs of banking.

This essay employs the production approach by using the translog function to estimate bank efficiency. The conventional translog cost function plus input share equation, modified by Christensen and Greene (1976), are generally used in the studies of banks' X-efficiency.[45] However, McAllister and McManus (1993) and Mitchell and Onvural (1996) showed that the translog function might under-represent some of the results of scale economies because of the ill-fit of the translog function across a wide range of bank size. Berger and Mester (1997) argued that a more flexible functional form could reduce the problems of the translog function. They suggested the Fourier-flexible

---

[45] Christensen and Greene (1970) estimated economies of scale for U.S. firms, which produced electronic power from 1955 to 1970 by using the stochastic parametric cost frontier, which incorporated technical, allocative, and cost efficiency.

function form which augments the translog function by including Fourier trigonometric terms.[46]

The fourier-flexible function is more flexible than the translog function. Gallant (1981) suggested that when including a second-order polynomial in the explanatory variables, a Fourier series representation of an unknown function could achieve a given level of approximation error with fewer trigonometric terms. McAllister and McManus (1993), Berger and DeYoung (1997), and Mitchell and Onvural (1996) also showed that Fourier-flexible function is a global approximation to virtually any cost or profit function and fits the data for U.S. financial institutions better than the translog function. Furthermore, Berger and DeYoung (1997) provided the empirical evidence showing that measured inefficiencies were about doubled when the translog function was specified in place of the Fourier-flexible function.

Mitchell and Onvural (1996) asserted that permitting sample size to guide numbers of terms in cost functions might be unique on initial encounter, but it lies at the heart of the difference between parametric an semi-nonparametric methods. When using a parametric method, as one does with the translog function, one holds the maintained hypothesis that the bank industry's true cost function has the translog form. If this

[46] See Gallant (1981 and 1982), Chalfant and Gallant (1985), Eastwood and Gallant (1991), and Gallant and Souza (1991) for detail of the Fourier-flexible function form.

maintained hypothesis actually is false, misspecification error can cause tests of hypotheses such as the hypothesis of constant returns to scale, to be rejected when they are actually true. Although a Taylor series expansion may approximate a function around the expansion point in a mathematical sense, White (1980) demonstrated that ordinary least squares estimates of a second-order polynomial have a true Taylor series interpretation only under highly restrictive conditions.

Flexible functional forms are used in econometrics because these forms allow to modeling of second-order effects, for example, elasticity of substitution, which is the second derivative of the production, cost, or utility function. The translog function is the most widely used functional forms. Berndt and Christensen (1973) showed that the translog model is often interpreted as a second-order approximation to an unknown functional form. Previous studies, like Aigner and Chu (1968), Bentson, Hanweck, and Humphrey (1982), Berger (1993), Berger, Hunter, and Timme (1993), Berger and Mester (1997), Berger and DeYoung (1997), Berger and Hannan (1997), Berger and Humphey (1997), DeYoung (1997), and Evanoff (1998), employed the translog function by using cross-sectional regression. In order to permit zero outputs, Clark and Speaker (1994) utilized a generalized translog cost function to evaluate scale and scope economies. Kwan and Eisenbeis (1996) asserted that there is little information on how X-efficiencies in the banking industry might evolve over time in response to market forces and on how the rankings of X-efficiencies of individual banking firms might change over time. Both Kwan and Eisenbeis (1996) and Peristiani (1997) assumed the cost function to be stationary over time. Pooled time-series cross-sectional observations were used to estimate the stochastic cost frontier.

5.4 Data and Methodology

The Reports of Condition and Income Report Guide (Call Report) is the source of the banks' output and input data. The study period is from the first quarter of 1988 to the fourth quarter of 1997. We use the translog flexible function form to estimate the cost structure of banks and to derive the measure of the bank efficiency.[47] The translog function has been widely used to analyze the cost characteristics of depository institutions.[48] The standard tranlog function is given by the following:

$$\ln TC_{ti} = a_0 + \sum_{k=1}^{6} b_k \ln(y_{kti}) + \sum_{l-1}^{4} a_l \ln(p_{lti}) + 0.5\sum_{k=1}^{6}\sum_{j=1}^{6} b_{kj} \ln(y_{kti})\ln(y_{jti})$$
$$+ 0.5\sum_{l=1}^{4}\sum_{h=1}^{4} a_{lh} \ln(p_{lti})\ln(p_{hti}) + \sum_{k=1}^{6}\sum_{l=1}^{4} d_{lk} \ln(y_{kti})\ln(p_{lti}) + \ln(x_{ti}) + u_{ti}, \qquad (24)$$

---

[47] The translog function is also used as the cost equation in Mester (1987) and English et al. (1993)
[48] See the survey of Berger, Hunter, and Timme (1993) for the detail information.

where x_{ti} represents the X-efficiency factor and u_{ti} is the random error. The current specification assumes six standard bank outputs and four input prices. The specifications are the following:

TC_{ti} = total costs of bank i at time t = (total operating expenses + interest expenses)

y_k = bank outputs; (k=1) real estate loans, (k=2) agricultural loans, (k=3) commercial and industrial loans, (k=4) loans to individual for household, family, and other personal expenditures, (k=5)deposit liability – transaction accounts, and (k=6) deposit liability – nontransaction accounts.

p_l = price inputs; (l=1) total interest expenses, (l=2) price of capital (occupancy expenses, furniture, equipment and other non-interest expenses), and (l=3) salaries and employees benefits.

Cost-share equations are derived from Shephard's Lemma as follow:

$$\frac{\partial \ln TC_{ti}}{\partial \ln(p_{lti})} = S_{lti} = a_l + \sum_{h=1}^{4} a_{lh} \ln(p_{hti}) + \sum_{k=1}^{6} d_{lk} \ln(y_{kti}), \qquad (25)$$

A share equation is omitted in order to prevent singularity. We estimate the equation formed by equation (24) and (25) subject to homogeneity and symmetry restrictions by the method of seemingly unrelated regressions (SUR).

However, seemingly unrelated regressions (SUR) consider only the cross sectional relationship between the total costs (TC) and those banks' inputs and outputs simultaneously through 40 quarters, which is from the first quarter of 1988 to the fourth quarter of 1997. Thus, our new model considers the cross sectional and autocorrelation relationship of each variables. The rationale of the regression is as following:

$$TC_{i_{n*1}} = a_{0i_{n*1}} + b_k Y_{ki_{n*1}} + g_l P_{li_{n*1}} + 0.5h_m YY_{mi_{n*1}} + 0.5f_q PP_{qi_{n*1}} + d_j YP_{ji_{n*1}} + x'_{i_{n*1}} + u'_{i_{n*1}}, \qquad (26)$$

where TC_{in*1} means the n*1 matrix in total cost of commercial banks for each bank i. Y_{kin*1} is the matrix of the commercial bank's outputs and k is the number from 1 to 6 that k=1 is real estate loans, k=2 is agricultural loans, k=3 is commercial and industrial loans, k=4 is loans to individual for household, family, and other personal expenditures, k=5 is deposit liability – transaction accounts, and k=6 is deposit liability – nontransaction accounts. P_{lin*1} is the matrix of the commercial bank's price inputs and l is the number from 1 to 3 that l=1 is total interest expenses, l=2 is price of capital (occupancy expenses, furniture, equipment and other non-interest expenses), and l=3 salaries and employees benefits. YY_{min*1} and PP_{qin*1} are the matrix of the interaction within bank's outputs and price inputs respectively where m has 15 combinations and n has 3 combinations. Y_{pjin*1}

is the matrix of the interaction between the bank's output and input variables where j has 18 combinations. All variables are in logarithm terms in the matrix.

If a firm systematically incurs relatively higher costs than the other firms in a competitive environment, it is considered X-inefficient. In the survey of Berger, Hunter, and Timme (1993), there are several econometric and linear programming techniques have been proposed for estimating X-efficiency. They are Econometric Frontier Approach (EFA), Thick Frontier Approach (TFA), Data Envelopment Analysis (DEA), and Distribution-Free Approach (DFA). In this study, we assume the efficiency differences are stable over time, and the random error averages out over time. Thus, we employ the distribution-free approach proposed by Berger (1993) to estimate the efficiency of the banks.[49] From equation (24) and (26), we can define $e_{ti} = \ln(x_{ti}) + u_{ti}$ and $e'_{ti} = x'_{ti} + u'_{ti}$ respectively. We can observe the problem of the disturbance term of the equation (27). We assume that the inputs are autocorrelated and follow the AR(1) process. The derivation is as follow:

---

[49] See also the discussion in DeYoung (1997) for a diagnostic test for the distribution –free efficiency estimator.

$$e_{ti} = \boldsymbol{a} e_{t-1,i} + \boldsymbol{u}_{ti}, \qquad (27)$$

where

$E(\boldsymbol{u}_t) = 0,$

$E(\boldsymbol{u}_t^2) = \boldsymbol{s}_e^2,$

and

$Cov(\boldsymbol{u}_t, \boldsymbol{u}_1) = 0.$

$$Var(e_{ti}) = Var(ae_{t-1,i} + u_{ti}) = a^2 Var(e_{t-1,i}) + Var(u_{ti}) + 2aCov(e_{t-1,i}, u_{ti}), \qquad (28)$$

where

$Var(u_{ti}) = Var(e'_{ti}) = s^2$

Thus,

$Var(e_{ti})$

$= a^2 Var(e_{t-1,i}) + Var(u_{ti}) + 2aCov(e_{t-1,i}, u_{ti})$

$$= a^2 Var(e_{t-1,i}) + s^2 + 2aCov(e_{t-1,i}, u_{ti}) > s^2 = Var(u_{ti}) = Var(e'_{ti}), \qquad (29)$$

$$Var(e_{ti}) > Var(e'_{ti}). \qquad (30)$$

From equation (27), the variance of the error term (e_{ti}) of the traditional translog function is shown on equation (28). Thus, the variance of the error term (e_{ti}), which purely considers the cross section of the traditional translog function, can be expected to be greater than the variance of e'_{ti}, which considers the cross section and time series jointly (see equation (29) and (30)).

Peristiani (1997) indicates that residual can be transformed so that the minimum is zero. Thus:

$$\hat{e}_{ti} = \min\{\hat{e}_{ti}\} - \hat{e}_{ti}, \tag{31}$$

$$\hat{e}'_{ti} = \min\{\hat{e}'_{ti}\} - \hat{e}'_{ti}, \tag{32}$$

$$\hat{e}_{ti} > \hat{e}'_{ti}, \tag{33}$$

By taking the exponential of equation (31) and (32), we can obtain the efficiency as equation (34) and (35). However, because of the difference of the variance on equation (30), we can expect that the expected residual of the traditional translog function is greater than the expected residual of the alternative translog function, equation (33). Thus, X-efficiency (Xeff) derived from the traditional translog function (equation (34)) should have more variation than the X-efficiency (Xeff') derived from the alternative translog function (equation (35)).

$$XEFF_{ti} = \exp(\hat{e}_{ti}), \tag{34}$$

$$XEFF'_{ti} = \exp(\hat{e}'_{ti}), \tag{35}$$

$XEFF_{ti}$ is normalized to fall between zero and one. However, $XEFF_{ti}$ is not robust to outliers. Berger modifies the observations that fall below the p-th percentile are set to the p-th percentile value ($\hat{e}_{ti}^{(p)}$), and observations that exceed the (1-p)-th percentile are valued at ($\hat{e}_{ti}^{(1-p)}$). Thus, the modified X-efficiencies derived from traditional and alternative translog functions can be defined as:

$$XEFF_{ti}(p) = \exp[\hat{e}_{ti}^{(p)} - \max\{\hat{e}_{t}^{(p)}, \min\{\hat{e}_{ti}, \hat{e}_{t}^{(1-p)}\}], \tag{36}$$

$$XEFF'_{ti}(p) = \exp[\hat{e}_{ti}'^{(p)} - \max\{\hat{e}_{t}'^{(p)}, \min\{\hat{e}'_{ti}, \hat{e}_{t}'^{(1-p)}\}] \tag{37}$$

5.5 Empirical Study

In order to show the differences between the traditional and alternative translog functions, several empirical analyses are conducted. All commercial banks during the periods between 1988 and 1997 are used to form the cost frontier. The criteria that we use as a filter is that the charter type in the call report should be 200, 210, 250, or 340 and the primary issuer code and total assets are both greater than zero. By using different methodologies, shown in equation (27) and equation (28), two different residuals are formed. After getting two different residual from equation (31) and equation (32), we form two different X-efficient frontiers of all commercial banks.

Since two sets of X-efficiency data for commercial banks in the United States are available by using different approaches, the differences of banks X-efficiencies are observed. Commercial banks' X-efficiencies derived from the alternative translog function are expected to be lower than those derived from the traditional translog function because of the time-series problems in the traditional translog function. Furthermore, the newly developed X-efficiencies of commercial banks are also applied to the examinations done in the essay I and essay II, which are the economies of scale in the banking industry and the relationship between X-efficiency and monetary policy and macroeconomic factors. Moreover, the lead and lag relationship between large and small banks are also compared by traditional and alternative X–efficiency estimations.

5.6 Results

In this essay, some empirical tests in chapter 3 and 4 are applied to test the alternative estimate of X-efficiency that we develop. Simple statistics of traditional and alternative X-efficiency estimation are shown in Table 45 and Table 46. The results show that the mean of traditional estimation is higher than that of alternative estimation. The volatility within the industry in every year is also higher for the alternative efficiency estimation. Economies of scale in the banking industry are also examined. Economies of scale do exist in the banking industry by traditional X-efficiency estimation shown in

Figure 13. However, Figure 14 shows that it is not the case for the alternative X-efficiency estimation. If the observations are categorized based on bank specialization in agriculture, there is a range of optimal size in agricultural banks by the traditional approach (Figure 15).[50] Economies of scale exist for non-agricultural banks (Figure 17). However, Figure 16 and Figure 18 show that the alternative estimation does not exhibit the economies scale for the specialty and non-specialty banks. Pairwise comparisons are conducted to examine the optimal size of the bank. For the traditional estimation, Table 47 shows that specialty banks with total assets between 20 and 250 million dollars outperform non-specialty banks. With the alternative approach, Table 48 shows the optimal size for the banks with agricultural specialization is between 90 and 100 million dollars in total assets. Yet, non-agricultural banks outperform agricultural banks in 400 to 500 million dollars of bank size. Other than those two ranges of bank size, there is no difference between the efficiency of agricultural and non-agricultural banks. Economies of scale disappear when the alternative estimation is applied. The efficiency of large banks declines in the new approach. The major difference between the traditional and new approaches is the autocorrelation in the error term. Large banks might gain an advantage for the better past performance. Thus, when the bank size increases, it cost efficiency improves by the traditional estimation which ignores the autocorrelation issue in the efficiency estimation. The alternative estimation can examine bank efficiency

[50] Agricultural banks are defined as banks with more than 25 percent agricultural loans of total loans.

independently without the influence of the past performance. Therefore, large banks might not have an advantage in cost efficiency by employing the alternative X-efficiency estimation.

The basic bank information model in chapter 3 is also examined in this essay. Table 49 and Table 50 show the results between bank efficiency and bank fundamental information by the traditional and newly developed approaches respectively. In Table 49, the results from three different regressions based on different criteria are consistent with traditional estimation. The adjusted R squares are all less than 1 percent. In Table 50, the results using the alternative estimation are different from those by traditional estimation shown in Table 49. For the alternative estimation, the average agricultural loan ratio is not statistical significant. The multiplier effect of agricultural loan and bank size with the tradition estimation (Table 49) does not exist in the alternative estimation. However, the competitiveness of the local financial markets (bkcapita) does have a significant positive impact on bank efficiency. The volatility of agricultural loan ratio does not play an important role in the alternative estimation. Seasonal effects do affect bank efficiency significantly. However, the first and second quarters have a significant negative influence on bank efficiency when estimated with the alternative approach.

The relationship between bank efficiency and macro economic conditions is tested and the results are shown in Table 51. The change of bank size, market returns, the dummy of the Federal Reserve discount-rate changes, and the second quarter have significant negative impact on bank efficiency by traditional estimation and positive significant impact on bank efficiency using the alternative estimation. Default premium, federal funds premium, bank competitiveness, and Federal Deposit Insurance Corporation Improvement Act have significant positive effects on bank efficiency using traditional estimation and negative effects using the alternative estimation. However, the percentage change of total loans and gross domestic production influence bank efficiency positively by traditional estimation but not by alternative estimation.

Finally, the lead and lag relationships between large and small banks are examined.[51] Simple statistics of large and small banks' X-efficiencies by traditional and alternative estimation are shown in Table 52, Table 53, Table 54, and Table 55. Since the time series properties of X-efficiency of both large and small banks are not stationary, first differencing of X-efficiency is taken in order to make the data stationary. In Table 56, Table 57, Table 58, and Table 59, the results show that only the percentage changes of large and small banks' X-efficiency estimated by traditional approach are stationary. Lead and lag relationship are examined and the results shown in Table 60 indicate that the improvement of large bank efficiency enhances the change of small bank efficiency simultaneously. Although the results shown in Table 61 by alternative estimation support those in Table 60 by traditional estimation, the non-stationary properties of the percentage change efficiency estimated by the alternative approach shown in Table 61, indicate the results may be biased

---

[51] 3 million dollars in total assets is the cutoff between large and small banks.

5.7 Conclusion

After considering the autocorrelation issue of the X-efficiency estimation, we find that X-efficiency estimated by the alternative approach is lower than that by traditional estimation. Large banks might lose the advantage of gaining cost efficiency after the consideration of autocorrelation in X-efficiency estimation. Thus, economies of scale do not exist when using the alternative estimation.

Autocorrelation might be an important issue in the process of X-efficiency estimation. However, in order to test the lead and lag relationship between large and small bank efficiency, the alternative estimation, which takes autocorrelation into account, might lead to significant problems for the tests of the lead and lag relationship. Thus, the results are still ambiguous as to whether the estimation of X-efficiency should consider autocorrelation in the estimation process.

TABLE 45. STATISTICS OF TRADITIONAL ESTIMATED BANKS' X-EFFICIENCY

Number (N), mean (Mean), standard deviation (STD), minimum (Minimum), and maximum (Maximum) of all available commercial banks' X-efficiency in each period

Quarter/Year	N	Mean	STD	Minimum	Maximum
01/88	13493	0.9615389	0.0164629	0.9342307	1
02/88	13362	0.962879	0.0154328	0.9386537	1
03/88	13188	0.9653512	0.0142411	0.9441017	1
04/88	13071	0.9650262	0.0140527	0.9448373	1
01/89	12951	0.9702176	0.0120363	0.9534684	1
02/89	12901	0.969858	0.0119853	0.9538302	1
03/89	12778	0.9698037	0.0119138	0.9539253	1
04/89	12658	0.9664573	0.0128582	0.9496647	1
01/90	12547	0.9716948	0.011123	0.9565151	1
02/90	12456	0.971914	0.0109893	0.9572652	1
03/90	12362	0.9712227	0.0111101	0.9565828	1
04/90	12298	0.9705493	0.011386	0.955826	1
01/91	12205	0.9704031	0.0114006	0.9555581	1
02/91	12108	0.9672958	0.0125561	0.950956	1
03/91	12025	0.9684136	0.0121872	0.9528333	1
04/91	11872	0.9689972	0.0121807	0.9539456	1
01/92	11759	0.9623393	0.0144966	0.9449686	1
02/92	11638	0.9620402	0.0146812	0.9450204	1
03/92	11545	0.9610776	0.0150112	0.9439562	1
04/92	11424	0.9556204	0.0173887	0.9351169	1
01/93	11290	0.9531283	0.0177285	0.9337138	1
02/93	11161	0.948415	0.0194748	0.9275312	1
03/93	11047	0.9517172	0.0186091	0.93076	1
04/93	10933	0.9530229	0.0174107	0.9350429	1
01/94	10816	0.9563527	0.0157603	0.9403875	1
02/94	10694	0.9561427	0.0157536	0.9401388	1
03/94	10566	0.9559631	0.0159887	0.9390213	1
04/94	10424	0.9564464	0.0156869	0.9402391	1
01/95	10212	0.958814	0.0145525	0.943151	1
02/95	10142	0.9595763	0.0145391	0.9436393	1
03/95	10025	0.9602	0.0143501	0.9447016	1
04/95	9914	0.9586622	0.01486	0.9423382	1
01/96	9807	0.9615499	0.0138218	0.9451512	1
02/96	9660	0.9598226	0.0144524	0.9420214	1
03/96	9556	0.9468016	0.0203983	0.9169477	1
04/96	9498	0.9574082	0.0155628	0.9380668	1
01/97	9417	0.9587427	0.0150062	0.9401945	1
02/97	9266	0.9559556	0.015883	0.9371955	1
03/97	9177	0.9540928	0.0161803	0.9353275	1
04/97	9101	0.9526131	0.016795	0.9331643	1

TABLE 46. STATISTICS OF ALTERNATIVE ESTIMATED BANKS' X-EFFICIENCY
Number (N), mean (Mean), standard deviation (STD), minimum (Minimum), and maximum (Maximum) of all available commercial banks' X-efficiency in each period

Quarter/Year	N	Mean	STD	Minimum	Maximum
01/88	12905	0.931358	0.036014	0.866035	1
02/88	12968	0.947903	0.025407	0.895805	1
03/88	13014	0.955892	0.021156	0.913664	1
04/88	12899	0.949327	0.023829	0.90267	1
01/89	13260	0.884779	0.052183	0.792426	1
02/89	13204	0.945523	0.026216	0.894561	1
03/89	13086	0.956171	0.021359	0.913998	1
04/89	12969	0.947632	0.025131	0.897133	1
01/90	12859	0.895449	0.04824	0.80791	1
02/90	12770	0.946089	0.025383	0.897598	1
03/90	12677	0.952642	0.022178	0.908915	1
04/90	12608	0.950603	0.02335	0.904402	1
01/91	12515	0.890413	0.049818	0.79987	1
02/91	12418	0.94646	0.025318	0.8962	1
03/91	12335	0.952408	0.021997	0.908871	1
04/91	12188	0.952782	0.02386	0.903519	1
01/92	12079	0.884814	0.053587	0.789203	1
02/92	11975	0.945919	0.026137	0.894308	1
03/92	11892	0.956189	0.0207	0.916842	1
04/92	11793	0.949809	0.026147	0.895553	1
01/93	11699	0.88883	0.051419	0.800049	1
02/93	11601	0.946544	0.025072	0.899353	1
03/93	11499	0.955197	0.020213	0.918359	1
04/93	11395	0.954115	0.022903	0.907146	1
01/94	11299	0.903498	0.044722	0.824224	1
02/94	11173	0.947463	0.024217	0.902434	1
03/94	11046	0.953367	0.020701	0.916231	1
04/94	10913	0.955157	0.022496	0.909562	1
01/95	10705	0.877508	0.055841	0.785043	1
02/95	10634	0.945136	0.02605	0.896141	1
03/95	10514	0.953869	0.021664	0.912015	1
04/95	10399	0.950678	0.024263	0.900003	1
01/96	10300	0.887609	0.052825	0.786947	1
02/96	10144	0.929475	0.03071	0.871579	1
03/96	10049	0.946156	0.023637	0.900129	1
04/96	10001	0.953355	0.025338	0.895392	1
01/97	9932	0.885487	0.049399	0.801199	1
02/97	9797	0.940106	0.026589	0.890297	1
03/97	9642	0.952808	0.022679	0.90636	1
04/97	9501	0.948612	0.026409	0.891044	1

TABLE 47. COMPARISON OF TRADITIONAL ESTIMATED X-EFFICIENCY BASED ON LOAN SPECIALIZATION IN DETAILED SIZE CATEGORIES

This table contains the comparison of bank efficiency based on loan specialization by using the detailed size categories. Cochran statistics are used to test the difference between efficiencies of banks without agricultural loan specialization (NA) and banks with agricultural loan specialization (A). Because of the lack of observations of banks with agricultural loan specialization, the results of the banks with $600 million or higher in total assets are not available.

Size (total assets, million dollars)	t Value (NA-A)	Results
0-10	24.18***	NA>A
10-20	13.12***	NA>A
20-30	-19.62***	A>NA
30-40	-18.99***	A>NA
40-50	-24.59***	A>NA
50-60	-16.45***	A>NA
60-70	-16.63***	A>NA
70-80	-12.92***	A>NA
80-90	-8.27***	A>NA
90-100	-10.18***	A>NA
100-150	-9.7***	A>NA
150-200	-2.51**	A>NA
200-250	-3.11***	A>NA
250-300	1.29	NA=A
300-400	3.8***	NA>A
400-500	4.33***	NA>A
500-600	.	.
600-700	.	.
700-800	.	.
800-900	.	.
900-1000	.	.
1000-1500	.	.
1500-2000	.	.
2000-3000	.	.
3000-5000	.	.
5000-10000	.	.
>10000	.	.

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively. Values are for the statistics using the Cochran and Cox approximation.

TABLE 48. COMPARISON OF ALTERNATIVE ESTIMATED X-EFFICIENCY BASED ON LOAN SPECIALIZATION IN DETAILED SIZE CATEGORIES

This table contains the comparison of bank efficiency based on loan specialization by using the detailed size categories. Cochran statistics are used to test the difference between efficiencies of banks without agricultural loan specialization (NA) and banks with agricultural loan specialization (A). Because of the lack of observations of banks with agricultural loan specialization, the results of the banks with $600 million or higher in total assets are not available.

Size (total assets, million dollars)	t Value (NA-A)	Results
0-10	-0.99	NA=A
10-20	-1.30	NA=A
20-30	0.46	NA=A
30-40	-0.15	NA=A
40-50	0.76	NA=A
50-60	0.95	NA=A
60-70	-1.58	NA=A
70-80	-1.09	NA=A
80-90	-1.95*	A>NA
90-100	-0.51	NA=A
100-150	-0.56	NA=A
150-200	-0.92	NA=A
200-250	-0.60	NA=A
250-300	0.35	NA=A
300-400	-0.88	NA=A
400-500	2.59	NA>A
500-600	.	.
600-700	.	.
700-800	.	.
800-900	.	.
900-1000	.	.
1000-1500	.	.
1500-2000	.	.
2000-3000	.	.
3000-5000	.	.
5000-10000	.	.
>10000	.	.

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively. Values are for the statistics using the Cochran and Cox approximation.

TABLE 49. THE FUNDAMENTAL INFORMATION MODEL BY TRADITIONAL X-EFFICIENCY ESTIMATION

This table contains results of the estimation of the fundamental information model for explaining banks' X-efficiencies. Size is the size of the bank, measured by total assets in logarithm term. $Size^2$ represents the size of the bank in squared. $Size^3$ shows the size of the bank in cubed. AAR is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets. Inter is an interaction term, testing the relationship between agricultural loans and bank's size. Bkcapita represents banks per capita in the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on the quarterly data of average agricultural loans over the 10-year examination period. q_j = dummy variables measuring seasonal effect. q1 represents first quarter, q2 represents second quarter, and q3 represents third quarter. $XEFF_i$ is the average efficiency of each commercial bank over 1988-1997 periods.

$$XEFF_i = a + b_1 size_i + b_2 size^2{}_i + b_3 size^3{}_i + b_4 AAR_i + b_5 Inter_i + b_5 bkcapita_i + b_6 Agprice_i + \sum_{j=1}^{3} g_j q_j$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variable			
intercept	1.07545***	2.62388***	1.07718***
size	-0.02762***	-0.49307***	-0.02642***
$size^2$	0.00203***	0.04795***	0.00182***
$size^3$	-0.00004369***	-0.00153***	-0.00003590***
AAR	-0.10998***	-0.06214***	-0.23956***
Inter	0.01082***	0.00732***	0.02158***
Bkcapita	4.14366***	3.79562***	7.35801***
Agprice	-2.87701E-8***	-5.56486E-7***	-3.28334E-8***
q1	0.00194***	0.00207***	0.00194***
q2	0.00092125***	0.00092995***	0.00094170***
q3	0.00023268***	0.00028747*	0.00023137***
Adjusted R^2:	0.0341	0.086	0.0341

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively.

TABLE 50. THE FUNDAMENTAL INFORMATION MODEL BY ALTERNATIVE X-EFFICIENCY ESTIMATION

This table contains results of the estimation of the fundamental information model for explaining banks' X-efficiencies. Size is the size of the bank, measured by total assets in logarithm term. $Size^2$ represents the size of the bank in squared. $Size^3$ shows the size of the bank in cubed. AAR is the average agricultural loan ratio, calculated from the average agricultural loans divided by the total assets. Inter is an interaction term, testing the relationship between agricultural loans and bank's size. Bkcapita represents banks per capita in the county level, which is the proxy of the competitiveness of the local financial market. Bkcapita is the ratio of number of commercial banks chartered in the county to the population of the county. Agprice shows the volatility of agricultural loans based on the quarterly data of average agricultural loans over the 10-year examination period. q_j = dummy variables measuring seasonal effect. q1 represents first quarter, q2 represents second quarter, and q3 represents third quarter. $XEFF_i$ is the average efficiency of each commercial bank over 1988-1997 periods.

$$XEFF_i = a + b_1 size_i + b_2 size^2{}_i + b_3 size^3{}_i + b_4 AAR_i + b_5 Inter_i + b_5 bkcapita_i$$
$$+ b_6 Agprice_i + \sum_{j=1}^{3} g_j q_j$$

Observations	All Banks	Agricultural Banks	Non-Agricultural Banks
Variable			
Intercept	0.88447***	1.14131***	0.87688***
Size	0.01758***	-0.05951**	0.01967***
$size^2$	-0.00149***	0.00617**	-0.00167***
$size^3$	0.00004046***	-0.00021179**	0.0000459***
AAR	0.00491	0.00113	0.00119
Inter	-0.00077884*	-0.00017423	-0.00055115
bkcapita	0.83372**	0.80871*	1.20364**
agprice	0.000000000000721788*	0.00000000000326377	0.000000000000717221*
q1	-0.05761***	-0.05752***	-0.05762***
q2	-0.00715***	-0.00698***	-0.00719***
q3	0.0023***	0.00193***	0.00238***
Adjusted R^2	0.3575	0.3583	0.3574

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively.

TABLE 51. THE RELATIONSHIP BETWEEN BANK EFFICIENCY AND MACRO ECONOMIC CONDITIONS BY DIFFERENT X-EFFICIENCY ESTIMATIONS

This table contains the results of the estimation of the regression model for bank efficiency changes by size categories. The variables used in the model are the percentage change of bank size, percentage change of total loans, market return based on CRSP equal weighted index, bull/bear market dummy variable, dividend yield, default premium, dummy variable for federal discount-rate change, federal funds premium, banks per capita at the county level, quarter dummy variables (q1 q2 q3), percentage change of gross domestic production, percentage change of unemployment rate, percentage change of leading indicator, and dummy variables of important deregulation acts, respectively.

$$\Delta XEFF_{it} = \boldsymbol{a} + \boldsymbol{b}_1 \Delta Size_{it} + \boldsymbol{b}_2 \Delta TL_{it} + \boldsymbol{b}_3 MR_{it} + \boldsymbol{b}_4 BB_{it} + \boldsymbol{b}_5 DP_{it} + \boldsymbol{b}_6 DEF_{it} + \boldsymbol{b}_7 DIR_{it}$$
$$+ \boldsymbol{b}_8 FFP_{it} + \boldsymbol{b}_9 \Delta BPC_{it} + \boldsymbol{b}_{10} SEASON_{it} + \boldsymbol{b}_{11} \Delta GDP_{it} + \boldsymbol{b}_{12} \Delta UNEMP_{it}$$
$$+ \boldsymbol{b}_{13} \Delta LEAD_{it} + \boldsymbol{b}_{14} FIRREA_{it} + \boldsymbol{b}_{15} FDICIA_{it} + \boldsymbol{b}_{16} RNIBBEA_{it} + \boldsymbol{e}_{it}$$

Variables	Parameter Estimate	
	Traditional Estimation	**Alternative Estimation**
Adjusted R2	0.0774	0.4654
Intercept	-0.01501***	0.04734***
ΔSize	-0.00055894***	0.00242***
ΔTL	0.00000332***	0.0000058
MR	-0.00564***	0.0263***
BB	0.00408***	0.00078276**
DP	1.26744***	-5.25234***
DEF	-0.00938	-1.21403***
DIR	-0.00014495***	0.0033***
FFP	0.08767***	-0.59277***
BPC	0.31135***	-0.34457
q1	0.00204***	-0.0686***
q2	-0.00054744***	0.05871***
q3	0.0019***	0.00835***
ΔGDP	0.49055***	-0.02396
ΔUNEMP	0.03982***	0.18341***
Δlead	-0.29672***	-0.49657***
FIRREA	-0.00003819	0.00983***
FDICIA	0.00206***	-0.00247***
RNIBBEA	-0.00041174***	-0.00805***

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively.

TABLE 52. TIME SERIES PROPERTIES OF LARGE BANK EFFICIENCY BY TRADITIONAL X-EFFICIENCY ESTIMATION

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	2.46E-05	1	0
1	1.52E-05	0.6162	0.158114
2	9.08E-06	0.36877	0.209727
3	6.03E-06	0.24462	0.225355
4	4.83E-06	0.19593	0.231898
5	2.91E-06	0.11831	0.236
6	-1.27E-06	-0.05158	0.237478
7	-2.38E-06	-0.09667	0.237758
8	-5.11E-06	-0.20766	0.238739

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	27.68	6	0.0001	0.616	0.369	0.245	0.196	0.118	-0.052

TABLE 53. TIME SERIES PROPERTIES OF LARGE BANK EFFICIENCY BY ALTERNATIVE X-EFFICIENCY ESTIMATION

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	0.000846	1	0
1	-9E-05	-0.10662	0.158114
2	-0.00028	-0.32991	0.159901
3	-0.00021	-0.24791	0.176097
4	0.000522	0.61689	0.184616
5	-7.5E-05	-0.08811	0.230458
6	-0.00022	-0.25833	0.231298
7	-0.00015	-0.17747	0.238402
8	0.00031	0.36644	0.241683

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	29.52	6	<.0001	-0.107	-0.330	-0.248	0.617	-0.088	-0.258

TABLE 54. TIME SERIES PROPERTIES OF SMALL BANK EFFICIENCY BY TRADITIONAL X-EFFICIENCY ESTIMATION

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	4.74E-05	1	0
1	3.99E-05	0.84026	0.158114
2	3.51E-05	0.7408	0.245564
3	3.24E-05	0.68226	0.296212
4	2.83E-05	0.59719	0.33319
5	2.32E-05	0.48889	0.358953
6	1.57E-05	0.332	0.375231
7	1.11E-05	0.23331	0.382504
8	6.76E-06	0.14261	0.386045

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	109.37	6	<.0001	0.840	0.741	0.682	0.597	0.489	0.332

TABLE 55. TIME SERIES PROPERTIES OF SMALL BANK EFFICIENCY BY ALTERNATIVE X-EFFICIENCY ESTIMATION

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	0.000677	1	0
1	-0.00014	-0.21193	0.158114
2	-0.00032	-0.46655	0.165062
3	-0.00016	-0.24153	0.195267
4	0.00058	0.85685	0.202598
5	-0.00012	-0.17164	0.278847
6	-0.00028	-0.41318	0.281476
7	-0.00017	-0.25199	0.296251
8	0.000519	0.76752	0.301562

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	58.32	6	<.0001	-0.212	-0.467	-0.242	0.857	-0.172	-0.413

TABLE 56. TIME SERIES PROPERTIES OF PERCENTAGE CHANGE OF LARGE BANK EFFICIENCY BY TRADITIONAL X-EFFICIENCY ESTIMATION

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	1.87E-05	1	0
1	-3.30E-06	-0.17654	0.160128
2	-2.27E-06	-0.12145	0.165044
3	-2.18E-06	-0.11675	0.167319
4	1.08E-06	0.05789	0.169395
5	1.33E-06	0.0711	0.169902
6	-9.25E-07	-0.04946	0.170663
7	6.89E-07	0.03685	0.17103
8	-9.06E-07	-0.04849	0.171234

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	3.06	6	0.8008	-0.177	-0.121	-0.117	0.058	0.071	-0.049

TABLE 57. TIME SERIES PROPERTIES OF PERCENTAGE CHANGE OF LARGE BANK EFFICIENCY BY ALTERNATIVE X-EFFICIENCY ESTIMATION

Autocorrelations			
Lag	Covariance	Correlation	Std Error
0	0.0022908	1	0
1	-0.0009213	-0.40217	0.160128
2	-0.0002672	-0.11666	0.184216
3	-0.0008495	-0.37083	0.1861
4	0.0016023	0.69943	0.204169
5	-0.0005413	-0.23629	0.258404
6	-0.0002267	-0.09895	0.263886
7	-0.0005343	-0.23324	0.264836
8	0.00099515	0.43441	0.270051

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	38.95	6	<.0001	-0.402	-0.117	-0.371	0.699	-0.236	-0.099

TABLE 58. TIME SERIES PROPERTIES OF PERCENTAGE CHANGE OF SMALL BANK EFFICIENCY BY TRADITIONAL X-EFFICIENCY ESTIMATION

	Autocorrelations		
Lag	Covariance	Correlation	Std Error
0	1.5E-05	1	0
1	-3.02E-06	-0.20124	0.160128
2	-1.89E-06	-0.12593	0.166486
3	1.98E-06	0.13154	0.168911
4	7.40E-07	0.04931	0.171517
5	-1.23E-07	-0.00821	0.171881
6	-5.99E-08	-0.00399	0.171891
7	3.94E-08	0.00263	0.171893
8	-8.71E-07	-0.05801	0.171894

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	3.27	6	0.7739	-0.201	-0.126	0.132	0.049	-0.008	-0.004

TABLE 59. TIME SERIES PROPERTIES OF PERCENTAGE CHANGE OF SMALL BANK EFFICIENCY BY ALTERNATIVE X-EFFICIENCY ESTIMATION

	Autocorrelations		
Lag	Covariance	Correlation	Std Error
0	0.0020504	1	0
1	-0.0008238	-0.40179	0.160128
2	-0.0003811	-0.18587	0.184173
3	-0.0007233	-0.35276	0.188922
4	0.0017628	0.85974	0.205117
5	-0.000668	-0.32578	0.282805
6	-0.0003156	-0.15391	0.292269
7	-0.0007125	-0.34751	0.29434
8	0.0016025	0.78155	0.304679

Autocorrelation Check for White Noise

To Lag	Chi-Square	DF	Pr > ChiSq	--------------------Autocorrelations--------------------					
6	53.72	6	<.0001	-0.402	-0.186	-0.353	0.860	-0.326	-0.154

TABLE 60. LEAD AND LAG RELATIONSHIPS IN SMALL AND LARGE BANKS' EFFICIENCY BY TRADITIONAL X-EFFICIENCY ESTIMATION

The following are the results of the model as shown below using traditional X-efficiency estimation.

$$\Delta XEFF_{St} = b_1 \Delta XEFF_{St-1} + b_2 \Delta XEFF_{St-2} + \cdots\cdots + b_n \Delta XEFF_{St-n} + b_{n+1} \Delta XEFF_{Lt+1} + b_{n+2} \Delta XEFF_{Lt} + b_{n+3} \Delta XEFF_{Lt-1} + e_{it},$$

Centered R**2	0.846063
R Bar **2	0.783089
Uncentered R**2	0.848949
T x R**2 27.166	
Mean of Dependent Variable	-0.000567214
Std Error of Dependent Variable	0.004169672
Standard Error of Estimate	0.001941970
Sum of Squared Residuals	0.0000829675
Regression F(9,22)	13.4351
Significance Level of F	0.00000049
Durbin-Watson Statistic	1.774582
Q(8-0)	1.838463
Significance Level of Q	0.98556986

Variable	Coefficient	Std Error	T-Stat
Constant	-0.000670925	0.000372671	-1.80031*
$\Delta XEFF_{St-1}$	-0.223822956	0.209539215	-1.06817
$\Delta XEFF_{St-2}$	0.010877243	0.096500168	0.11272
$\Delta XEFF_{St-3}$	0.075756928	0.095434712	0.79381
$\Delta XEFF_{St-4}$	-0.041279614	0.107031749	-0.38568
$\Delta XEFF_{St-5}$	-0.071924607	0.12520395	-0.57446
$\Delta XEFF_{St-6}$	0.096457309	0.126254933	0.76399
$\Delta XEFFL_{t+1}$	0.03494987	0.081420897	0.42925
$\Delta XEFF_{Lt}$	0.83011372	0.084579393	9.81461***
$\Delta XEFF_{Lt-1}$	0.140526845	0.186507327	0.75347

***, **, and * represent 1%, 5%, and 10% statistical significance levels, respectively.

TABLE 61. LEAD AND LAG RELATIONSHIPS IN SMALL AND LARGE BANKS' EFFICIENCY BY ALTERNATIVE X-EFFICIENCY ESTIMATION

The following are the results of the model as shown below using alternative X-efficiency estimation.

$$\Delta XEFF_{St} = b_1 \Delta XEFF_{St-1} + b_2 \Delta XEFF_{St-2} + \cdots\cdots + b_n \Delta XEFF_{St-n} + b_{n+1} \Delta XEFF_{Lt+1}$$
$$+ b_{n+2} \Delta XEFF_{Lt} + b_{n+3} \Delta XEFF_{Lt-1} + e_{it},$$

Centered R**2	0.974654
R Bar **2	0.964285
Uncentered R**2	0.974712
T x R**2	31.191
Mean of Dependent Variable	0.0022436300
Std Error of Dependent Variable	0.0473918523
Standard Error of Estimate	0.0089563184
Sum of Squared Residuals	0.0017647441
Regression F(9,22)	93.9978
Significance Level of F	0.00000000
Durbin-Watson Statistic	1.824902
Q(8-0)	7.755928
Significance Level of Q	0.45766775

Variable	Coeff	Std Error	T-Stat
Constant	0.008096	0.003339	2.42505**
$\Delta XEFF_{St-1}$	-1.01705	0.209099	-4.86399***
$\Delta XEFF_{St-2}$	-0.95072	0.305284	-3.11421***
$\Delta XEFF_{St-3}$	-0.83157	0.337692	-2.46252**
$\Delta XEFF_{St-4}$	0.035958	0.329558	0.10911
$\Delta XEFF_{St-5}$	0.074639	0.249202	0.29951
$\Delta XEFF_{St-6}$	0.092452	0.136549	0.67706
$\Delta XEFFL_{t+1}$	-0.01943	0.060805	-0.31961
$\Delta XEFF_{Lt}$	0.117812	0.067376	1.74858*
$\Delta XEFF_{Lt-1}$	0.084784	0.063131	1.34297

***, **, and * represent 1%, 5%, and 10% statistical significant level respectively.

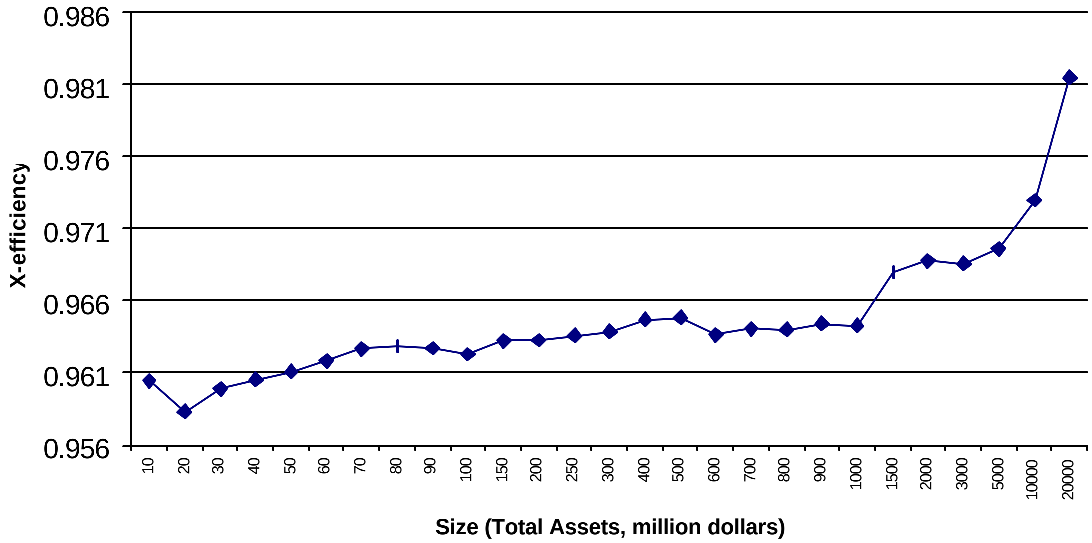

FIGURE 13. TRADITIONAL ESTIMATED X-EFFICIENCY OF ALL COMMERCIAL BANKS
This figure shows the quarterly average X-efficiency of banks based on different size categories using traditional X-efficiency estimation.

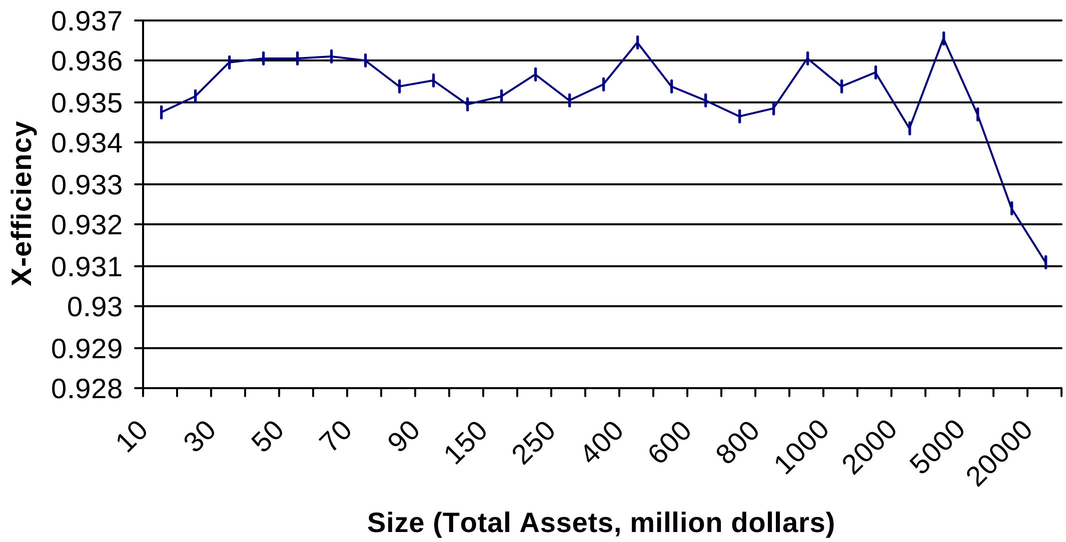

FIGURE 14. ALTERNATIVE ESTIMATED X-EFFICIENCY OF ALL COMMERCIAL BANKS
This figure shows the quarterly average X-efficiency of banks based on different size categories using alternative X-efficiency estimation.

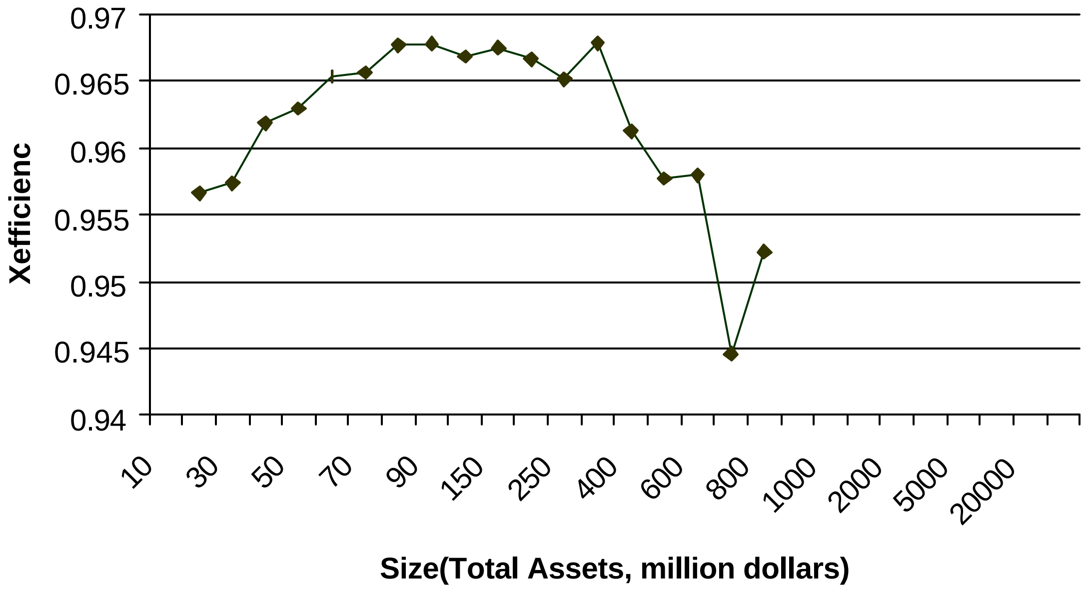

FIGURE 15. TRADITIONAL ESTIMATED X-EFFICIENCY OF COMMERCIAL BANKS WITH SPECIALIZATION IN AGRICULTURAL LOANS

This figure shows the quarterly average X-efficiency of banks with specialization in agricultural loans based on different size categories using traditional X-efficiency estimation.

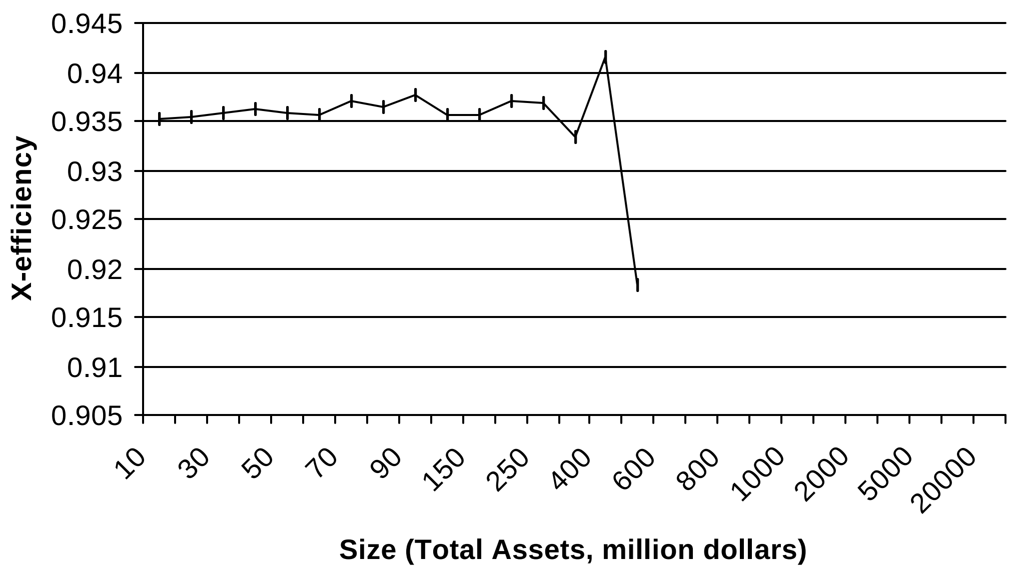

FIGURE 16. ALTERNATIVE ESTIMATED X-EFFICIENCY OF COMMERCIAL BANKS WITH SPECIALIZATION IN AGRICULTURAL LOANS

This figure shows the quarterly average X-efficiency of banks with specialization in agricultural loans based on different size categories using alternative X-efficiency estimation.

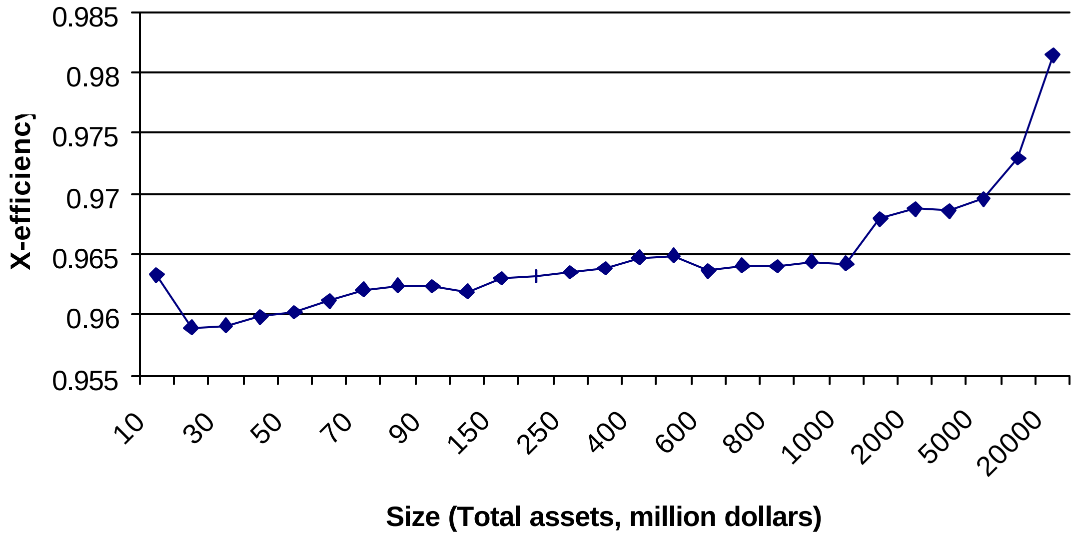

FIGURE 17. TRADITIONAL ESTIMATED X-EFFICIENCY OF COMMERCIAL BANKS WITH SPECIALIZATION IN NON-AGRICULTURAL LOANS

This figure shows the quarterly average X-efficiency of banks with no specialization in agricultural loans based on different size categories using traditional X-efficiency estimation.

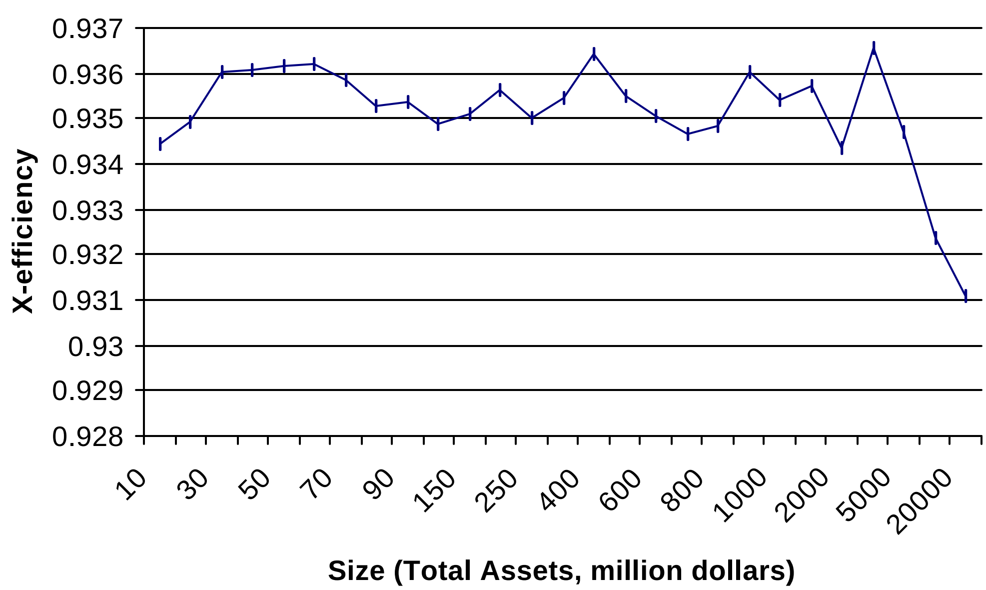

FIGURE 18. ALTERNATIVE ESTIMATED X-EFFICIENCY OF COMMERCIAL BANKS WITH SPECIALIZATION IN NON-AGRICULTURAL LOANS

This figure shows the quarterly average X-efficiency of banks with no specialization in agricultural loans based on different size categories using alternative X-efficiency estimation.

Bibliography

1. Aigner, D. J. and S. F. Chu. "On Estimating The Industry Production Function," *American Economic Review*, 1968, v58(4), 826-839.

2. Allen, Paul R. and William J. Wilhelm. "The Impact Of The 1980 Depository Institutions Deregulation And Monetary Control Act On Market Value And Risk: Evidence From The Capital Markets," *Journal of Money, Credit and Banking*, 1988, v20(3), Part 1, 364-380.

3. Aly, Hassan Y., Richard Grabowski, Carl Pasurka and Nanda Rangan. "Technical, Scale, And Allocative Efficiencies In U.S. Banking: An Empirical Investigation," *Review of Economics and Statistics*, 1990, v72(2), 211-218.

4. Ahrendsen, Bruce L., Alan D. Barkema and Cole R. Gustafson. "Weighing Regulatory Costs In Agricultural Lending," *American Journal of Agricultural Economics*, 1995, v77(3), 751-756.

5. Akhavein, Jalal D., Allen N. Berger and David B. Humphrey. "The Effects Of Megamergers On Efficiency And Prices: Evidence From A Bank Profit Function," *Review of Industrial Organization*, 1997, v12(1,Feb), 95-138.

6. Akhigbe, Aigbe and James E. McNulty. "The profit Efficiency of Small U.S. Commercial Banks, " *working paper*, July 2000.

7. Alam, Ila M. Semenick. "A Nonparametric Approach for Assessing Productivity Dynamics of Large U.S. Banks, " *Journal of Money, Credit, and Banking*, 2001, v33(1, Feb), 121-139.

8. Allen, Linda and Anoop Rai. "Operational Efficiency In Banking: An International Comparison," *Journal of Banking and Finance*, 1996, v20(4,May), 655-672.

9. Allen, Linda and Anoop Rai. "Operational Efficiency In Banking: An International Comparison," *Journal of Banking and Finance*, 1997, v21(10,Oct), 1451-1455.

10. American Bankers Association. "Farm bankers forecast an iffy future," *ABA Banking Journal*, 1995, v87(2), 10.

11. American Bankers Association. "Nation's farm banks aiming for a good 1997," *ABA Banking Journal*, 1997, v89(11), 8.

12. Arend, Mark. "Farm Credit Moves Cloud Ag Bank Picture: Newly Aggressive and Expansion-Minded Farm Credit System Has Bankers Crying "Foul." Credit Overcapacity Threatens to Erode Ag Bankers' Hard-Won Gains," *ABA Banking Journal*, 1992, v84(August, 8), 43-45.

13. Arah, Bernard Kaku Ndarku, Jr. "Agricultural Bank Efficiency and the Role of Managerial Risk Preferences (Bank Efficiency)," *dissertation*, University OF Georgia, 1998.

14. Barkema, Allan. "The Farm Slump Continues," *FRB Kansas City - Economic Review*, 2000, v85(1), 43-55.

15. Barr, Richard S., Kory A. Killgo, Thomas F. Siems and Sheri Zimmel. "Evaluating the Productive Efficiency and Performance of U.S. Commercial Banks," *Financial Industry Studies Working Paper No. 3-99*, Federal Reserve Bank of Dallas, December 1999.

16. Bauer, P. W. and D. Hancock. "The Efficiency Of The Federal Reserve In Providing Check Processing Services," *Journal of Banking and Finance*, 1993, v17(2/3), 287-316.

17. Bauer, Paul W., Allen N. Berger, Gary D. Ferrier and David B. Humphrey. "Consistency Conditions For Regulatory Analysis Of Financial Institutions: A Comparison Of Frontier Efficiency Methods," *Journal of Economics and Business*, 1998, v50(2,Mar/Apr), 85-114.

18. Bauer, Paul W. and Brian A. Cromwell. "A Monte Carlo Examination Of Bias Tests In Mortgage Lending," *FRB Cleveland - Economic Review*, 1994, v30(3), 27-40.

19. Belongia, Michael T. and R. Alton Gilbert. "The Farm Credit Crisis: Will It Hurt The Whole Economy?" *FRB St. Louis - Review*, 1985, v67(10), 5-15.

20. Belongia, Michael T. and R. Alton Gilbert. "Agricultural Banks: Causes Of Failures And The Condition Of Survivors," *FRB St. Louis - Review*, 1987, v69(5), 30-37.

21. Belongia, Michael T. and R. Alton Gilbert. "The Effects Of Management Decisions On Agricultural Bank Failures," *American Journal of Agricultural Economics*, 1990, v72(4), 901-910.

22. Benston, George J. and George G. Kaufman. "Deposit Insurance Reform In The FDIC Improvement Act: The Experience To Date," *FRB Chicago - Economic Perspectives*, 1998, v22(2,Second-Qtr), 2-20.

23. Benston, George J.,Gerald A. Hanweck and David B. Humphrey. "Scale Economies In Banking: A Restructuring And Reassessment," *Journal of Money, Credit and Banking*, 1982, v14(4), Part 1, 435-456.

24. Berger, Allen N., Gerald A. Hanweck and David B. Humphrey. "Competitive Viability In Banking: Scale, Scope, And Product Mix Economies," *Journal of Monetary Economics*, 1987, v20(3), 501-520.

25. Berger, Allen N., Margaret K. Kyle, Joseph M. Scalise. "Did U.S. Bank Supervisors Get Tougher During the Credit Crunch? Did they Get Easier During the Banking Boom? Did it Matter to Bank Lending?" *Forthcoming in Prudential Supervision: What Works and What Doesn't*, Edit by Frederic S. Mishkin, National Bureau of Economic Research, University of Chicago Press.

26. Berger, Allen N., John H. Leusner and John J. Mingo. "The Efficiency Of Bank Branches," *Journal of Monetary Economics*, 1997, v40(1,Sep), 141-162.

27. Berger, A. N. and T. H. Hannan. "Using Efficiency Measures To Distinguish Among Alternative Explanations Of The Structure-Performance Relationship In Banking," *Managerial Finance*, 1997, v23(1), 6-31.

28. Berger, Allen N. "Issues In Measuring The Efficiencies Of Agricultural Banks," *American Journal of Agricultural Economics*, 1994, v76(3), 672-674.

29. Berger, Allen N., William C. Hunter, and Stephen G. Timme. "The Efficiency of Financial Institutions: A Review and Preview of Research Past, Present, and Future," *Journal of Banking and Finance*, 1993, v17, 221-249.

30. Berger, Allen N. "'Distribution-Free' Estimates of Efficiency in the U.S. Banking Industry and Tests of the Standard Distributional Assumptions," *Journal of Productivity Analysis*, 1993, v4 (September), 261-292.

31. Berger, Allen N. and Loretta J. Mester. "Inside The Black Box: What Explains Differences In The Efficiencies Of Financial Institutions?" *Journal of Banking and Finance*, 1997, v21(7,Jul), 895-947.

32. Berger, Allen N. and Robert DeYoung. "Problem Loans And Cost Efficiency In Commercial Banks," *Journal of Banking and Finance*, 1997, v21(6,Jun), 849-870.

33. Berger, Allen N. and David B. Humphrey. "Efficiency of Financial Institutions: International Survey and Directions for Future Research," *European Journal of Operational Research*, 1997, v98, 175-212.

34. Berger, Allen N. and David B. Humphrey. "Measurement and Efficiency Issues in Commercial Banking," *In Output Measurement in the Service Sectors*, Edit by Zvi Griliches, Chicago: University of Chicago Press, 1992, 245-300.

35. Berger, Allen N. and David B. Humphrey. "The Dominance Of Inefficiencies Over Scale And Product Mix Economies In Banking," *Journal of Monetary Economics*, 1991, v28(1), 117-148..

36. Berger, Allen N. and Gregory F. Udell. "Relationship Lending And Lines Of Credit In Small Firm Finance," *Journal of Business*, 1995, v68(3), 351-381.

37. Berger, Allen N., Rebecca S. Demsetz and Philip E. Strahan. "The Consolidation Of The Financial Services Industry: Causes, Consequences, And Implications For The Future," *Journal of Banking and Finance*, 1999, v23(2-4,Feb), 135-194.

38. Berger, Allen N. and Loretta J. Mester. "What Explain the Dramatic changes in Cost and Profit performance of the U.S. Banking Industry?" *Working Paper*, Board of Governors of the Federal Reserve System, 1999.

39. Berger, Allen N., Seth D. Bonime, Daniel M. Covitz, and Diana Hancock. "Why Are Bank Profits So Persistent? The Roles of Product Market Competition, Informational Opacity, and Regional/Macroeconomic Shocks" *Journal of Banking and Finance*, 2000, v24(7), 1203-1235.

40. Berlin, M. and L. J. Mester. "Deposits And Relationship Lending," *Review of Financial Studies*, 1999, v12(3,Fall), 579-607.

41. Berlin, Mitchell and Loretta J. Mester. "On The Profitability And Cost Of Relationship Lending," *Journal of Banking and Finance*, 1998, v22(6-8,Aug), 873-897.

42. Bernanke, Ben S. and Alan S. Blinder. "The Federal Funds Rate And The Channels Of Monetary Transmission," *American Economic Review*, 1992, v82(4), 901-921.

43. Berndt, Ernst R. and Laurits R. Christensen. "The Translog Function And The Substitution Of Equipment Structures, And Labor In U.S. Manufacturing 1929-68," *Journal of Econometrics*, 1973, v1(1), 81-113.

44. Bertoletti, Paolo and Clara Poletti. "X-Inefficiency, Competition And Market Information," *Journal of Industrial Economics*, 1997, v55(4,Dec), 359-375.

45. Bhardwaj, Ravinder K and LeRoy D. Brooks. "Dual Betas From Bull And Bear Markets: Reversal Of The Size Effect," *Journal of Financial Research*, 1993, v16(4), 269-283.

46. Bhattacharya, Sudipto and Anjan V. Thakor. "Contemporary Banking Theory," *Journal of Financial Intermediation*, 1993, v3(1), 2-50.

47. Bhattacharya, Sudipto, Arnoud W. A. Boot and Anjan V. Thakor. "The Economics Of Bank Regulation," *Journal of Money, Credit and Banking*, 1998, v30(4,Nov), 745-770.

48. Boot, Arnoud W. A. and Anjan V. Thakor. "Can Relationship Banking Survive Competition?" *Journal of Finance*, 2000, v55(2), 679-713.

49. Brickley, James A., Clifford W. Smith, Jr., and James S. Linck. “Boundaries of the Firm: Evidence from the Banking Industry,” *Working Paper No. FR 00-01*, The Bradly Policy Research Center Financial Research and Policy, 2000 (January).

50. Bronstien, Barbara F. “Most-Efficient Ag Banks Focus on Cost Control with a Skeleton Staff,” *American Banker*, July 31, 1995, v160(145), 7.

51. Bronstien, Barbara F. “Ag Bankers Protesting Farm Credit Expansion,” *American Banker*, Dec 11, 1995, v160(237), 1-2.

52. Brown, Judy. "How High-Performance Community Banks Cope with the Effects of Deregulation?" *Journal of Retail Banking Services*, 1983, v5(3), 17-24.

53. Bundt, T. P., T. F. Cosimano and J. A. Halloran. "DIDMCA And Bank Market Risk: Theory And Evidence," *Journal of Banking and Finance*, 1992, v16(6), 1179-1194.

54. Button, Kenneth J. and Thomas G. Weyman-Jones. "X-Efficiency And Technical Efficiency," *Public Choice*, 1994, v80(1/2), 83-104.

55. Button, Kenneth J. and Thomas G. Weyman-Jones. "Ownership Structure, Institutional Organization, And Measured X-Efficiency," *American Economic Review*, 1992, v82(2), 439-445.

56. Calem, Paul S. "Branch Banking And The Geography Of Bank Pricing," *Review of Economics and Statistics*, 1998, v80(4,Nov), 600-610.

57. Calem, Paul S. "The Impact Of Geographic Deregulation On Small Banks," *FRB Philadelphia - Business Review*, 1994, v1994(6), 19-31.

58. Calem, Paul S. "Branch Banking And The Geography Of Bank Pricing," *Review of Economics and Statistics*, 1998, v80(4,Nov), 600-610.

59. Calomiris, Charles W. and Charles M. Kahn. “The Role of Demandable Debt in Structuring Optimal Banking Arrangements,” *American Economic Review*, 1991, v81(3), 497-513.

60. Calomiris, Charles W. and Joseph R. Mason. “Contagion and Bank Failures During the Great Depression: The June 1932 Chicago Banking Panic,” *American Economic Review*, 1997, v87(5 Dec), 863-883.

61. Calomiris, Charles W. "Gauging The Efficiency Of Bank Consolidation During A Merger Wave," *Journal of Banking and Finance*, 1999, v23(2-4,Feb), 615-621.

62. Campbell, John Y. “Stock Returns and the Term Structure,” *Journal of Financial Economics*, 1987, v18, 373-399.

63. Canhoto, Ana and Jean Dermine. “A Non-Parametric Evaluation of Banking Efficiency in Portugal, New vs Old Banks,” *working paper*, 2000.

64. Carow, Kenneth A. and Glen A. Larsen, Jr. "The Effect Of FDICIA Regulation On Bank Holding Companies," *Journal of Financial Research*, 1997, v20(2,Summer), 159-174.

65. Carow, Kenneth A. and Randall A. Heron. "The Interstate Banking And Branching Efficiency Act Of 1994: A Wealth Event For Acquisition Targets," *Journal of Banking and Finance*, 1998, v22(2,Feb), 175-196.

66. Cecen, A. Aydin. "X-Inefficiency, Productivity And Inflation: An Empirical Investigation," *Atlantic Economic Journal*, 1989, v17(1), 43-46.

67. Chalfant, James A. and A. Ronald Gallant. "Estimating Substitution Elasticities With The Fourier Costs Function: Some Monte Carlo Results," *Journal of Econometrics*, 1985, v28(2), 205-222.

68. Chang, Edward, Iftekhar Hasan and William C. Hunter. "Efficiency Of Multinational Banks: An Empirical Investigation," *Applied Financial Economics*, 1998, v8(6,Nov), 689-696.

69. Chatterjee, Satyajit. "Productivity Growth And The American Business Cycle," *FRB Philadelphia - Business Review*, 1995, v77(5), 13-21.

70. Chatterjee, Satyajit. "Real Business Cycles: A Legacy Of Countercyclical Policies?" *FRB Philadelphia - Business Review*, 1999, v1999(1,Jan/Feb), 17-27.

71. Chatterjee, Satyajit. "From Cycles to Shocks: Progress in Business-Cycle Theory," *FRB Philadelphia - Business Review*, 1999, v2000(2,March/April), 1-11.

72. Chauvet, Marcelle and Simon Potter. “Coincident and Leading Indicators of the Stock Market,” *Journal of Empirical Finance*, 2000, v7(1), 87-111.

73. Christensen, Laurits R. and William H. Greene. "Economies Of Scale In U.S. Electric Power Generation," *Journal of Political Economy,* 1976, v84(4), Part I, 655-676.

74. Christiano, Lawrence J. and Terry J. Fitzgerald. "The Business Cycle: It's Still A Puzzle," *FRB Chicago - Economic Perspectives*, 1998, v22(4,Fourth-Qtr), 56-83.

75. Christiano, Lawrence J. and Lars Ljungqvist. "Money Does Granger-Cause Output In The Bivariate Money-output Relation," *Journal of Monetary Economics*, 1988, v22(2), 217-236.

76. Clark, Jeffrey A. and Paul J. Speaker. "Economies Of Scale And Scope In Banking: Evidence From A Generalized Translog Cost Function," *Quarterly Journal of Business & Economics*, 1994, v33(2), 3-25.

77. Cocheo, Steve. "Ag banks see sixth straight earnings rise," *ABA Banking Journal*, 1993, v85(9), 9.

78. Cocheo, Steve. "ABA, IBAA propose Farm Credit System revamp," *ABA Banking Journal*, 1995, v87(6), 9.

79. Cocheo, Steve. "Program Allows Ag Banks to Have Loan and "Sell" it too," *ABA Banking Journal*, 1998, v90(8), 7.

80. Cogley, Timothy. "Evaluating Non-Structural Measures The Business Cycle," *FRB San Francisco - Economic Review*, 1997, v1997(3), 3-21.

81. Cole, Rebel A. and John D. Wolken. "Financial Services Used by Small Businesses: Evidence from the 1993 National Survey of Small Business Finances," *Federal Reserve Bulletin*, 1995, July, 629-640.

82. Cole, Rebel A. "The Importance Of Relationships To The Availability Of Credit," *Journal of Banking and Finance*, 1998, v22(6-8,Aug), 959-977.

83. Cole, Rebel A. and Hamid Mehran. "The Effect Of Changes In Ownership Structure On Performance: Evidence From The Thrift Industry," *Journal of Financial Economics*, 1998, v50(3,Dec), 291-317.

84. Collender, Robert N. " Future Directions for Agricultural Banking Efficiency Research: Discussion," *American Journal of Agricultural Economics*, 1994, v76(3), 669-671.

85. Cornell, Bradford. "Money Supply Announcements And Interest Rates: Another View," *Journal of Business*, 1983, v56(1), 1-24.

86. Cornett, Marcia Millon and Hassan Tehranian. "An Examination Of The Impact Of The Garn-St. Germain Depository Institutions Act Of 1982 On Commercial Banks And Savings And Loans," *Journal of Finance*, 1990, v45(1), 95-112.

87. Cuevas, Carlos E. "Intermediation Costs In An Agricultural Development Bank: A Cost-Function Approach To Measuring Scale Economies," *American Journal of Agricultural Economics*, 1988, v70(2), 273-280.

88. Denis, David J. and Diane K. Denis. "Performance Changes Following Top Management Dismissals, " *Journal of Finance*, 1995, v50(4), 1029-1057.

89. Devaney, Mike and Bill Weber. "Local Characteristics, Contestability, And The Dynamic Structure Of Rural Banking: A Market Study," *Quarterly Review of Economics & Finance*, 1995, v35(3), 271-287.

90. DeYoung, R. "Bank Mergers, X-Efficiency, And The Market For Corporate Control," *Managerial Finance*, 1997, v23(1),32-47.

91. DeYoung, Robert. "A Diagnostic Test for the Distribution-Free Efficiency Estimator: An Example using U.S. Commercial Bank Data, " *European Journal of Operational Research*, forthcoming 1997.

92. DeYoung, Robert. "Measuring Bank Cost Efficiency: Don't Count On Accounting Ratios," *Financial Practice and Education*, 1997, v7(1,Spring/Summer), 20-31.

93. DeYoung, Robert and Iftekhar Hasan. "The Performance Of De Novo Commercial Banks: A Profit Efficiency Approach," *Journal of Banking and Finance*, 1998, v22(5,May), 565-587.

94. DeYoung, Robert, Iftekhar Hasan and Bruce Kirchhoff. "The Impact Of Out-Of-State Entry On The Cost Efficiency Of Local Commercial Banks," *Journal of Economics and Business*, 1998, v50(2,Mar/Apr), 191-203.

95. DeYoung, Robert. "Operational Efficiency In Banking: An International Perspective: Comment," *Journal of Banking and Finance*, 1997, v21(10,Oct), 1325-1329.

96. DeYoung, Robert. "Management Quality And X-Inefficiency In National Banks," *Journal of Financial Services Research*, 1998, v13(1,Feb), 5-22.

97. DeYoung, Robert. "The Efficiency of Financial Institutions: How Does Regulation Matter?" *Journal of Economics and Business*, 1998, v50(2), 79-83

98. Diamond, Douglas W. and Philip H. Dybvig. "Bank Runs, Deposit Insurance, and Liquidity, " *Journal of Political Economy*, 1993, v91(3), 401-419.

99. Diamond, Douglas W. and Philip H. Dybvig. "Banking Theory, Deposit Insurance, And Bank Regulation," *Journal of Business*, 1986, v59(1), 55-68.

100. Dobson, John. "Agency Costs In U.S. Manufacturing: An Empirical Measure Of X-Efficiency," *Journal of Economics and Finance*, 1992, v16(1), 1-10.

101. Donaldson, R. Glen. "Costly Liquidation, Interbank Trade, Bank Runs and Panics," *Journal of Financial Intermediation*, 1992, v2(1), 59-82.

102. Donaldson, R. Glen. "Financing Banking Crisis: Lessons from the Panic of 1907," *Journal of Monetary Economics*, 1993, v31(1), 69-95.

103. Drabenstott, Mark. "Rethinking Rural America's Financial Markets. (Seeds of Change)," *Forum for Applied Research and Public Policy*, 1999, v14(1), 96-100.

104. Drabenstott, Mark and Larry Meeker. "Financing Rural America: A Conference Summary," *Financing Rural America*, Federal Reserve Bank of Kansas City, April 1997, 1-10.

105. Duncan, Marvin and Richard D. Taylor. "Opportunities For Rural Community Banks In Farm Lending," *FRB Kansas City - Economic Review*, 1993, v78(4), 41-52.

106. Eastwood, Brian J. and A. Ronald Gallant. "Adaptive Rules For Seminonparametric Estimators That Achieve Asymptotic Normality," *Econometric Theory*, 1991, v7(3), 307-340.

107. Eichberger, Jurgen and Ian R. Harper. "On Deposit Interest Rate Regulation And Deregulation," *Journal of Industrial Economics*, 1989, v38(1), 19-30.

108. Ellinger, Paul N. "Potential Gains From Efficiency Analysis Of Agricultural Banks," *American Journal of Agricultural Economics*, 1994, v76(3), 652-654.

109. Elsas, Ralf and Jan Pieter Krahnen. "Is Relationship Lending Special? Evidence From Credit-File Data In Germany," *Journal of Banking and Finance*, 1998, v22(10-11,Oct), 1283-1316.

110. Ely, Bert. "Good Times for Ag: Will They Last? (Farming Finances)," *ABA Banking Journal*, 1998, v90(3), 42-45.

111. Elyasiani, Elyas and Seyed M. Mehdian. "A Nonparametric Approach To Measurement Of Efficiency And Technological Change: The Case Of Large U.S. Commercial Banks," *Journal of Financial Services Research*, 1990, v4(2), 157-168.

112. Elyasiani, E. and S. Mehdian. "Efficiency In The Commercial Banking Industry, A Production Frontier Approach," *Applied Economics*, 1990, v22(4), 539-552.

113. English, M., S. Grosskopf, K. Hayes, and S. Yaisawarng. "Output Allocative and Technical Efficiency of Banks," *Journal of Banking and Finance*, 1993, v17, 349-366.

114. Evanoff, Douglas D. "Assessing The Impact Of Regulation On Bank Cost Efficiency," *FRB Chicago - Economic Perspectives*, 1998, v22(2,Second-Qtr), 21-32.

115. Fama, Eugene F. and Kenneth R. French. "Dividend Yield and Expected Stock Returns," *Journal of Financial Economics*, 1988, v22 , 3-25.

116. Fama, Eugene F. and Kenneth R. French. "Business Conditions and Expected Returns on Stocks and Bonds," *Journal of Financial Economics*, 1989, v25, 23-49.

117. Fare, Rolf and Daniel Primont. "Measuring The Efficiency Of Multiunit Banking: An Activity Analysis Approach," *Journal of Banking and Finance*, 1993, v17(2/3), 539-544.

118. Featherstone, Allen M. and Charles B. Moss. "Measuring Economies Of Scale And Scope In Agricultural Banking," *American Journal of Agricultural Economics*, 1994, v76(3), 655-661.

119. Featherstone, Allen M. "Post-Acquisition Performance of Rural Banks," *American Journal of Agricultural Economics*, 1996, v78(3), 728-733.

120. Federal Financial Institutions Examination Council, *Reports of Condition and Income Report Guide (Call Report)*, 01/1988 – 04/1997.

121. Ferri, Giovanni and Marcello Messori. "Bank-Firm Relationships and Allocative Efficiency in Northeastern and Central Italy and in the South," *Journal of Banking and Finance*, 2000, v24, 1067-1095.

122. Ferrier, Gary D. and C.A. Knox Lovell. "Measuring Cost Efficiency in Banking: Econometric and Linear Programming Evidence, " *Journal of Econometric*, 1990, v46, 229-245.

123. Fixler, D. J. and K. D. Zieschang. "An Index Number Approach To Measuring Bank Efficiency: An Application To Mergers," *Journal of Banking and Finance*, 1993, v17(2/3), 437-450.

124. Fixler, Dennis J. and Kimberly D. Zieschang. "User Costs, Shadow Prices, and the Real Output of Banks," *Output Measurement in the Service Sectors*, Edit by Zvi Griliches, Chicago: University of Chicago Press, 1992, 219-243

125. Frantz, Roger. "X-Efficiency And Allocative Efficiency: What Have We Learned?" *American Economic Review*, 1992, v82(2), 434-438.

126. Fried, H. O., C. A. K. Lovell and P. Vanden Eeckaut. "Evaluating The Performance Of US Credit Unions," *Journal of Banking and Finance*, 1993, v17(2/3), 251-266.

127. Friedman, Milton and Anna J. Schwartz. "Money And Business Cycles," *Review of Economics and Statistics*, 1963, v45(1), Part 2, 32-64.

128. Gallant, A. Ronald. "On The Bias In Flexible Functional Forms And An Essentially Unbiased Form: The Fourier Flexible Form," *Journal of Econometrics*, 1981, v15(2), 211-246.

129. Gallant, A. Ronald. "Unbiased Determination Of Production Technologies," *Journal of Econometrics*, 1982, v20(2), 285-324.

130. Gallant, A. Ronald and Geraldo Souza. "On The Asymptotic Normality Of Fourier Flexible Form Estimates," *Journal of Econometrics*, 1991, v50(3), 329-354.

131. Gendreau, Brian C. "Bankers' Balances, Demand Deposit Interest, And Agricultural Credit Before The Banking Act Of 1933," *Journal of Money, Credit and Banking*, 1979, v11(4), 506-514.

132. Gilbert,R. Alton. "Economics Of Scale In Correspondent Banking," *Journal of Money, Credit and Banking*, 1983, v15(4), 483-488.

133. Gilbert, R. Alton. "Implication of Banking Consolidation for the Financial of Rural America," *Financing Rural America*, Federal Reserve Bank of Kansas City, 1997 (April), 131-140.

134. Gilbert, R. Alton. "National Branch Banking and the Presence of Large Banks in Rural Areas," *FRB St. Louis – Review*, 2000, v82(3), 13-28.

135. Gilbert, R. Alton and Kevin L. Kliesen. "Deregulation Or Reregulation Of Agricultural Banks," *American Journal of Agricultural Economics*, 1995, v77(3), 757-761.

136. Gilbert, R. Alton and Levis A. Kochin. "Local Economic Effects Of Bank Failures," *Journal of Financial Services Research*, 1989, v3(4), 333-346.

137. Gilbert, R. Alton and Michael T. Belongia. "The Effects Of Affiliation With Large Bank Holding Companies On Commercial Bank Lending To Agriculture," *American Journal of Agricultural Economics*, 1988, v70(1), 69-78.

138. Goldberg, Lawrence G. and Anoop Rai. "The Structure-Performance Relationship For European Banking," *Journal of Banking and Finance*, 1996, v20(4,May), 745-771.

139. Goldberg, Lawrence G. and Lawrence J. White. "De Novo Banking And Lending To Small Businesses: An Empirical Analysis," *Journal of Banking and Finance*, 1998, v22(6-8,Aug), 851-867.

140. Grabowski, R., N. Rangan and R. Rezvanian. "Organizational Forms In Banking: An Empirical Investigation Of Cost Efficiency," *Journal of Banking and Finance*, 1993, v17(2/3), 531-538.

141. Grabowski, Richard, Nanda Rangan and Rasoul Rezvanian. "The Effect Of Deregulation On The Efficiency Of U.S. Banking Firms," *Journal of Economics and Business*, 1994, v46(1), 39-54.

142. Gunther, Jeffrey W. “Geographic Liberalization and the Accessibility of Banking Services in Rural Areas,” *Financial Industry Studies Working Paper No. 1-97*, Federal Reserve Bank of Dallas, February 1997.

143. Hao, Jonathan, William C. Hunter and Won Keun Yang, “Deregulation and Efficiency: The Case of Private Korean Banks,” *Working Paper*, 1998, Federal Reserve Bank of Chicago.

144. Houston, Joel F. and Christopher James. "Do Bank Internal Capital Markets Promote Lending?" *Journal of Banking and Finance*, 1998, v22(6-8,Aug), 899-918.

145. Howton, Shelly W. and David R. Peterson. “An Examination of Cross-Sectional Realized Stock Returns Using a Varying-Risk Beta Model.” *The Financial Review*, 1998, v33 (August), 199-212.

146. Hughes, Joseph P., Loretta J. Mester, and Choon-Geol Moon. "Are Scale Economies in Banking Elusive or Illusive? Evidence Obtained by Incorporating Capital Structure and Risk-Taking," *working paper*, 2000.

147. Hughes, Joseph P. "Measuring Efficiency When Competitive Prices Aggregate Differences In Product Quality And Risk," *Research in Economics*, 1999, v53(1,Mar), 47-76.

148. Hughes, Joseph P., William W. Lang,. Loretta J. Mester and Choon-Geol Moon. "The Dollars And Sense Of Bank Consolidation," *Journal of Banking and Finance*, 1999, v23(2-4,Feb), 291-324.

149. Hughes, Joseph P., William Lang, Loretta J. Mester and Choon-Geol Moon. "Efficient Banking Under Interstate Branching," *Journal of Money, Credit and Banking*, 1996, v28(4,Nov), Part 2, 1045-1071.

150. Hughes, Joseph P. and Loretta J. Mester. "Bank Capitalization And Cost: Evidnce Of Scale Economies In Risk Management And Signaling," *Review of Economics and Statistics*, 1998, v80(2,May), 314-325.

151. Huh, Chan G. "Causality And Correlations Of Output And Nominal Variables In A Real Business Cycle Model," *Journal of Monetary Economics*, 1993, v32(1), 147-168.

152. Huh, Chan. "Forecasting Industrial Production Using Models With Business Cycles Asymmetry," *FRB San Francisco - Economic Review*, 1998, v1998(1), 29-41.

153. Humphrey, David B. " Costs and scale economies in bank intermediation, " *R.C. Asponwall and R. Eisenbeis, eds., Handbook of Banking Strategy*, Willey, New York, NY, 1985, 745-783.

154. Humphrey, David B. "Why Do Estimates Of Bank Scale Economies Differ?" *FRB Richmond - Economic Review*, 1990, v76(5), 38-50.

155. Humphrey, David B. and Lawrence B. Pulley. "Banks' Responses To Deregulation: Profits, Technology, And Efficiency," *Journal of Money, Credit and Banking*, 1997, v29(1,Feb), 73-93.

156. Humphrey, David B. "Productivity In Banking And Effects From Deregulation," *FRB Richmond - Economic Review*, 1991, v77(2), 16-28.

157. Hunter, William C., Stephen G. Timme and Won Keun Yang. "An Examination Of Cost Subadditivity And Multiproduct Production In Large U.S. Banks," *Journal of Money, Credit and Banking*, 1990, v22(4), 504-525.

158. Isijola, O. C. and J. O. Ajetomobi. "A Comparative Analysis Of Repayment Performance Of Small-Holder Agricultural Loan Scheme Of Two Selected Banks In Oyo State Of Nigeria," *Indian Journal of Economics*, 1998, v79(313), 259-272.

159. Jayaratne, Jith and John Wolken. "How Important Are Small Banks To Small Business Lending?" *Journal of Banking and Finance*, 1999, v23(2-4,Feb), 427-458.

160. Jayaratne, Jith and Philip E. Strahan. "The Finance-Growth Nexus: Evidence From Bank Branch Deregulation," *Quarterly Journal of Economics*, 1996, v111(3,Aug), 639-670.

161. Jensen, Gerald R., Jeffrey M. Mercer, and Robert R. Johnson. “Business Conditions, Monetary Policy, and Expected Security Returns,” *Journal of Financial Economics*, 1996, v40, 213-237.

162. Kakwani, N. C. "The Unbiasedness Of Zellner's Seemingly Unrelated Regression Equations Estimators," *Journal of the American Statistical Association*, 1967, v62(317), 141-142.

163. Kalish, Lionel, III and R. Alton Gilbert. "An Analysis Of Efficiency Of Scale And Organizational Form In Commercial Banking," *Journal of Industrial Economics*, 1973, v21(3), 293-307.

164. Kalish, Lionel, III and R. Alton Gilbert. "The Influence Of Bank Regulation On The Operating Efficiency Of Commercial Banks," *Journal of Finance*, 1973, v28(5), 1287-1301.

165. Kaufman, George G. “Bank Contagion: A Review of the Theory and Evidence,” *Journal of Financial Services Research*, 1994, v8(2), 123-150.

166. Kaufman, George G. *The U.S. Financial System*, 7th edition, 1995, Prentice Hall.

167. Keeton, William R. "Do Bank Mergers Reduce Lending To Businesses And Farmers? New Evidence From Tenth District States," *FRB Kansas City - Economic Review*, 1996, v81(3,Third-Qtr), 63-75.

168. Keeton, William R. "Are Rural Banks Facing Increased Funding Pressures? Evidence From Tenth District States," *FRB Kansas City - Economic Review*, 1998, v83(2,Second-Qtr), 43-67.

169. Keim, Donald B. and Robert F. Stambaugh. "Predicting Returns in the Stock and Bond Markets," *Journal of Financial Economics*, 1986, v17, 357-390

170. Keplinger, Keith, Gene Wilson, Sylvester Johnson and David Whitehead. "Agricultural Banks In The Southeast: How Are They Faring?" *FRB Atlanta - Economic Review*, 1985, v70(5), 4-19.

171. Kimball, Ralph C. "Relationship Versus Product In Retail Banking," *Journal of Retail Banking*, 1990, v12(1), 13-26.

172. King, Robert G. and Ross Levine. "Finance And Growth: Schumpeter Might Be Right," *Quarterly Journal of Economics*, 1993, v108(3), 717-737.

173. King, Robert G. and Ross Levine. "Finance, Entrepreneurship, And Growth: Theory And Evidence," *Journal of Monetary Economics*, 1993, v32(3), 513-542.

174. Kliesen, Kevin L. and R. Alton Gilbert. "Are Some Agricultural Banks Too Agricultural?" *FRB St. Louis - Review*, 1996, v78(1,Jan/Feb), 23-35.

175. Klinefelter, Danny A., John B. Penson and Donald F. Fraser. "Effects Of Inflation On Financial Markets And Agricultural Lending Institutions," *American Journal of Agricultural Economics*, 1980, v62(5), 1054-1059.

176. Kochar, Anjini. "Does Lack Of Access To Formal Credit Constrain Agricultural Production? Evidence From The Land Tenancy Market In Rural India," *American Journal of Agricultural Economics*, 1997, v79(3,Aug), 754-763.

177. Kolari, James W. and Donald R. Fraser. " The Effects of Deregulation on Bank Profitability: Can Small Banks Survive? " *Journal of Retail Banking*, 1984, v6(4), 1-11.

178. Kolari, James and Asghar Zardkoohi. "Further Evidence On Economies Of Scale And Scope In Commercial Banking," *Quarterly Journal of Business & Economics*, 1991, v30(4), 82-107.

179. Kraft, Evan, Dogbrevean Tinodot. "Bank Efficiency In Croatia: A Stochastic-Frontier Analysis," *Journal of Comparative Economics*, 1998, v26(2,Jun), 282-300.

180. Kwan, Simon and Robert A. Eisenbeis. "Bank Risk, Capitalization, And Operating Efficiency," *Journal of Financial Services Research*, 1997, v12(2/3,Oct/Dec), 117-131.

181. Kwan, Simon H. and Robert A. Eisenbeis. "An Analysis Of Inefficiencies In Banking," *Journal of Banking and Finance*, 1995, v19(3/4), 733-734.

182. Kwast, Myron L. "Panel Discussion of 'US Banking Consolidation and Efficiency – Myths and Realities' Discussion Comment on US Banking Consolidation and Efficiency," *Journal of Banking and Finance*, 1993, v17(2/3), 457-462..

183. Laderman, Elizabeth S., Ronald H. Schmidt and Gary C. Zimmerman. "Location, Branching, And Bank Portfolio Diversification: The Case Of Agricultural Lending," *FRB San Francisco - Economic Review*, 1991, v1991(1), 24-38.

184. LaDue, Eddyan and Marvin Duncan. "The consolidation of Commercial Banks in Rural Markets," *American Journal of Agricultural Economics*, 1996, v78(3), 718-720.

185. Lakonishok, Josef and Alan C. Shapiro. "Stock Returns, Beta, Variance And Size: An Empirical Analysis," *Financial Analyst Journal*, 1984, v40(4), 36-41.

186. Lam, Chun H. and Andrew H. Chen. "Joint Effects Of Interest Rate Deregulation And Capital Requirements On Optimal Bank Portfolio Adjustments," *Journal of Finance*, 1985, v40(2), 563-575.

187. Lawrence, David B. and Thomas G. Walkins. "Rural Banking Markets And Holding Company Entry," *Journal of Economics and Business*, 1986, v38(2), 123-130.

188. Lawrence, D. B. and M. R. Klugman. "Interstate Banking In Rural Markets: The Evidence From The Corn Belt," *Journal of Banking and Finance*, 1991, v15(6), 1081-1092.

189. Lee, Thomas K. "Efficiency, Market Structure, and Performance Relationship for the Global Banking Industry: A Comparative Analysis among Different Regimes," *dissertation*, The Catholic University of America, 1998.

190. Lehnert, Dick. "Farm Credit's Big Return," *Successful Farming*, 1994, v92(12), 46-47.

191. Leibenstein, Harvey. "Allocative Efficiency Vs. 'X-Efficiency'," *American Economic Review*, 1966, v56(3), 392-415.

192. Leibenstein, Harvey and Shlomo Maital. "Empirical Estimation And Partitioning Of X-Inefficiency: A Data-Envelopment Approach," *American Economic Review*, 1992, v82(2), 428-433.

193. Levonian, Mark E. "Explaining Differences in Farm Lending among Banks," *Economic Review*, Federal Reserve Bank of San Francisco, 1996, Number 3, 12-22.

194. Lins, David A. and Peter J. Barry. "Agency Status For The Cooperative Farm Credit System," *American Journal of Agricultural Economics,* 1984, v66(5), 601-606.

195. Lovonian, Mark E. "Transitions in Rural Financial Markets: Vision of Future Bank Structure - Discussion," *American Journal of Agricultural Economics,* 1996, v78(3), 734-735.

196. Madura, Jeff and Marilyn K. Wiley. "The Impact of the Financial Institutions Reform, Recovery and Enforcement Act on the Risk of Saving Institutions," *The Financial Review*, 2000, v35(3), 145-168.

197. McInnis, R. M. "Output and Productivity in Canadian Agriculture, 1870-71 to 1926-27," *Long-Term Factors in American Economic Growth*, edit by Stanley L. Engerman and Robert E. Gallman, University of Chicago Press 1986, 737-778.

198. McAllister, P. H. and D. McManus. "Resolving The Scale Efficiency Puzzle In Banking," *Journal of Banking and Finance*, 1993, v17(2/3), 389-406.

199. Mehta, J. S. and P. A. V. B. Swamy. "Further Evidence On The Relative Efficiencies Of Zellner's Seemingly Unrelated Regressions Estimator," *Journal of the American Statistical Association*, 1976, v71(355), 634-639.

200. Melichar, Emanuel. "Some Current Aspects Of Agricultural Finance And Banking In The United States," *American Journal of Agricultural Economics*, 1977, v59(5), 967-972.

201. Mester, Loretta J. "A Multiproduct Cost Study of Savings and Loans," *Journal of Finance*, 1997, v42(2) (June), 423-445.

202. Mester, Loretta J. "A Study Of Bank Efficiency Taking Into Account Risk-Preferences," *Journal of Banking and Finance*, 1996, v20(6,Jul), 1025-1045.

203. Mester, L. J. "Efficiency In The Savings And Loan Industry," *Journal of Banking and Finance*, 1993, v17(2/3), 267-286.

204. Mester, Loretta J. "Efficient Production Of Financial Services: Scale And Scope Economies," *FRB Philadelphia - Business Review*, 1987, v1987(1), 15-25.

205. Meyer, Laurence H. "The Present And Future Roles Of Banks In Small Business Finance," *Journal of Banking and Finance*, 1998, v22(6-8,Aug), 1109-1116.

206. Mitchell, Karlyn and Nur M. Onvural. "Economies Of Scale And Scope At Large Commercial Banks: Evidence From The Fourier Flexible Functional Form," *Journal of Money, Credit and Banking*, 1996, v28(2,May), 178-199.

207. Millar, James A. and Stanley R. Stansell. "Variable Rate Mortgage Experience Of The Farm Credit System," *Financial Management*, 1975, v4(4), 46-57.

208. Milbourn, Todd T., Arnoud W. A. Boot and Anjan V. Thakor. "Megamergers And Expanded Scope: Theories Of Bank Size And Activity Diversity," *Journal of Banking and Finance*, 1999, v23(2-4,Feb), 195-214.

209. Mishkin, Frederic S. and Stanley G. Eakins. *Financial Markets and Institutions*, Second Edition, Addison-Wesley, 1998.

210. Murray, John D. And Robert W. White. "Economies Of Scale And Economies Of Scope In Multiproduct Financial Institutions: A Study Of British Columbia Credit Unions," *Journal of Finance*, 1983, v38(3), 887-902.

211. Nakamura, Leonard I. "Small Borrowers and the Survival of the Small Bank: Is Mouse Bank Mighty or Mickey?" *Federal Reserve Bank of Philadelphia, Business Review*, 1994, November/December, 3-15.

212. Neely, Michelle C. and David C. Wheelock, "Why does Bank Performance Vary Across States?" *Federal Reserve Bank of St. Louis, Review*, 1997, March/April, 27-40.

213. Neff, David L. and Paul N. Ellinger. "Participants in Rural Bank Consolidations," *American Journal of Agricultural Economics*, 1996, v78(3), 721-727.

214. Neff, David L; Dixon, Bruce L; Zhu, Suzhen. "Measuring the efficiency of agricultural banks;" *American Journal of Agricultural Economics*, Aug 1994; v76(3); 662-668.

215. Osborne, Jon. "A Case Of Mistaken Identity: The Use Of Expense/Revenue Ratios To Measures Bank Efficiency," *Journal of Applied Corporate Finance*, 1995, v8(2), 55-59.

216. Pearce, Douglas K. and V. Vance Roley. "The Reaction Of Stock Prices To Unanticipated Changes In Money: A Note," *Journal of Finance*, 1983, v38(4), 1323-1333.

217. Pederson, Glenn D. "Agricultural Bank Portfolio Adjustments To Risk," *American Journal of Agricultural Economics*, 1992, v74(3), 672-681.

218. Peek, Joe and Eric S. Rosengren. "Bank Consolidation And Small Business Lending: It's Not Just Bank Size That Matters," *Journal of Banking and Finance*, 1998, v22(6-8,Aug), 799-819.

219. Petersen, Mitchell A. and Raghuram G. Rajan. "The Effect Of Credit Market Competition On Lending Relationship," *Quarterly Journal of Economics*, 1995, v110(2), 407-443.

220. Petersen, Mitchell A. and Raghuram G. Rajan. "The Benefits Of Lending Relationships: Evidence From Small Business Data," *Journal of Finance*, 1994, v49(1), 3-37.

221. Peristiani, Stavros. "Do Merger Improve the X-Efficiency and Scale Efficiency of U.S. Banks? Evidence from the 1980s," *Journal of Money, Credit, and Banking*, 1997, v29(3, August), 326-337.

222. Pi, L. and S. G. Timme. "Corporate Control And Bank Efficiency," *Journal of Banking and Finance*, 1993, v17(2/3), 515-530.

223. Pettengill, Glenn N., Sridhar Sundaram and Ike Mathur. "The Conditional Relation Between Beta And Returns," *Journal of Financial & Quantitative Analysis*, 1995, v30(1), 101-116.

224. Pulley, Lawrence B. and David B. Humphrey. "The Role Of Fixed Costs And Cost Complementarities In Determining Scope Economies And The Cost Of Narrow Banking Proposals," *Journal of Business*, 1993, v66(3), 437-462.

225. Radecki, Lawrence J. "The Expanding Geographic Reach Of Retail Banking Markets," FRB New York - Economic Policy Review, 1998, v4(2,Jun), 15-34.

226. Resti, Andrea. "Regulation Can Foster Mergers, Can Mergers Foster Efficiency? The Italian Case," *Journal of Economics and Business*, 1998, v50(2,Mar/Apr), 157-169.

227. Rhoades, Stephen A. "The Efficiency Effects Of Bank Mergers: An Overview Of Case Studies Of Nine Mergers," *Journal of Banking and Finance*, 1998, v22(3,Mar), 273-291.

228. Rhoades, S. A. "Efficiency Effects Of Horizontal (In-Market) Bank Mergers," *Journal of Banking and Finance*, 1993, v17(2/3), 411-422.

229. Rogers, Kevin E. "Nontraditional Activities And The Efficiency Of US Commercial Banks," *Journal of Banking and Finance*, 1998, v22(4,May), 467-482.

230. Rogers, Kevin. "Product Mix, Bank Powers, And Complementarities At U.S. Commercial Banks," *Journal of Economics and Business*, 1998, v50(2,Mar/Apr), 205-218.

231. Rose, John T. and John D. Wolken. "Geographic Diversification In Banking, Market Share Changes, And The Viability Of Small Independent Banks," *Journal of Financial Services Research*, 1990, v4(1), 5-20.

232. Rose, Peter S. "Implications of Future Research on Bank Consolidations in Rural Markets: Discussion," *American Journal of Agricultural Economics*, 1996, v78(3), 736-737.

233. Rossi, Clifford V. "Mortgage Banking Cost Structure: Resolving An Enigma," *Journal of Economics and Business*, 1998, v50(2,Mar/Apr), 219-234.

234. Saunders, Anthony. "Panel Discussion of ' The efficiency of Financial Institutions around the Globe' Comments on Efficiency Studies," *Journal of Banking and Finance*, 1993, v17(2/3), 551-557.

235. Saunders, Anthony and Berry Wilson. "Contagious Bank Runs: Evidence From The 1929-1933 Period," *Journal of Financial Intermediation*, 1996, v5(4,Oct), 409-423.

236. Saunders, Anthony. *Financial Institutions Management – A Modern Perspective*, Second Edition, 1997, Irwin, McGraw-Hill.

237. Schumpeter, Joseph A., *The Theory of Economic Development*, Cambridge, MA: Harvard University Press, 1911.

238. Schwert, G.William. "Stock Returns and Real Activity: A Century of Evidence," *Journal of Finance*, 1990, v45, 1237-1257.

239. Shaffer, S. "Can Megamergers Improve Bank Efficiency?" *Journal of Banking and Finance*, 1993, v17(2/3), 423-436.

240. Sherrick, Bruce J., Peter J. Barry, and Paul N. Ellinger. "Valuation of Credit Risk in Agricultural Mortgages," *American Journal of Agricultural Economics*, 2000, v82(February), 71-81.

241. Sims, Christopher A. "Money, Income, And Causality," *American Economic Review*, 1972, v62(4), 540-552.

242. Smith, Bruce D. and Michael J. Stutzer. "Adverse Selection And Mutuality: The Case Of The Farm Credit System," *Journal of Financial Intermediation*, 1990, v1(2), 125-149

243. Stanton, Kenneth Richard. " Essays on Efficiency Issues in Banking (Loans, Data Envelopment Analysis)," *Dissertation*, York University (Canada) 1998

244. Stevens, Jerry L. "Bank Market Concentration And Costs: Is There X-Inefficiency In Banking?" *Business Economics*, 1983, v18(3), 36-44.

245. Stigler, George J. "The Xistence Of X-Efficiency," *American Economic Review*, 1976, v66(1), 213-216.

246. Stiroh, Kevin J.. “How did Bank Holding Companies Prosper in the 1990s? “ *Journal of Banking and Finance*, 2000, v24, 1703-1745.

247. Stover, Roger D., R. Kenneth Teas and Roy J. Gardner. "Agricultural Lending Decision: A Multiattribute Analysis," *American Journal of Agricultural Economics*, 1985, v67(3), 513-520.

248. Strahan, Philip E. and James P. Weston. "Small Business Lending And The Changing Structure Of The Banking Industry," *Journal of Banking and Finance*, 1998, v22(6-8,Aug), 821-845.

249. Sullivan, Gene D. and Gene Wilson. "Farm Credit In The Southeast: Shakeout And Survival," *FRB Atlanta - Economic Review*, 1983, v68(1), 4-11.

250. Thakor, Anjan V. "Bank Efficiency And Financial System Evolution: An Analysis Of Complementary Problems In Transitional And State-dominated Economies," *Research in Economics*, 1998, v52(3,Sep), 271-284.

251. Tirtiroglu, Dogan, Kenneth N. Daniels and Ercan Tirtiroglu. "Total Factor Productivity Growth And Regulation In U.S. Commercial Banking During 1946-1995: An Empirical Investigation," *Journal of Economics and Business*, 1998, v50(2,Mar/Apr), 171-189.

252. Todd, Richard M. "Taking Stock Of The Farm Credit System: Riskier For Farm Borrowers," *FRB Minneapolis - Quarterly Review*, 1985, v4, 14-24.

253. Udell, Gregory F. “Loan Quality, Commercial Loan Review and Loan Officer Contracting,” *Journal of Banking and Finance*, 1989, v13 (July), 367-382

254. U.S. Department of Commerce. *1992 Census of Agriculture, Geographic Area Series*, 1992.

255. Walsh, Carl E. "Taxation Of Interest Income, Deregulation And The Banking Industry," *Journal of Finance*, 1983, v38(5), 1529-1542.

256. Weber, William L. and Michael Devaney. "Community Lending, Bank Efficiency, And Economic Dualism," *Growth and Change*, 1998, v29(2,Spring), 157-174.

257. Wheelock, David C. and Paul W. Wilson. "Technical Progress, Inefficiency, And Productivity Change In U.S. Banking, 1984-1993," *Journal of Money, Credit and Banking*, 1999, v31(2,May), 212-234.

258. Wheelock, David C. "Regulation And Bank Failures: New Evidence From The Agricultural Collapse Of The 1920s," *Journal of Economic History*, 1992, v52(4), 806-825.

259. White, Halbert. "Using Least Squares To Approximate Unknown Regression Functions," *International Economic Review*, 1980, v21(1), 149-170.

260. Wigmore, Barrie A. :Was the Bank Holiday of 1933 Caused by a Run on the Dollar?" *Journal of Economic History*, 1987, v47(3), 739-756.

261. Yamori, Nobuyoshi and Akinobu Murakami. "Does Bank Relationship Have An Economic Value?" *Economics Letters*, 1999, v65(1,Oct), 115-120.

262. Yosha, Oved. "Information Disclosure Costs And The Choice Of Financing Source," *Journal of Financial Intermediation*, 1995, v4(1), 3-20.

263. Zardkoohi, Asghar, Nanda Rangan and James Kolari. "Homogeneity Restrictions On The Translog Cost Model: A Note," *Journal of Finance*, 1986, v41(5), 1153-1156.

264. Zellner, Arnold. "An Efficient Method Of Estimating Seemingly Unrelated Regressions And Tests Of Aggregation Bias," *Journal of the American Statistical Association*, 1962, v57(298), 348-368.

265. Zellner, Arnold. "Estimators For Seemingly Unrelated Regression Equations: Some Exact Finite Sample Results," *Journal of the American Statistical Association*, 1963, v58(304), 977-992.

266. Zimmerman, Gary C. "Factors Influencing Community Bank Performance In California," *FRB San Francisco - Economic Review*, 1996, v1996(1), 26-42.

267. Zhu, Suzhen, Paul N. Ellinger and C. Richard Shumway. "The Choice Of Functional Form And Estimation Of Banking Inefficiency," *Applied Economics Letters*, 1995, v2(10), 375-379.

VITA

Yi-Kai Chen

Born on January 25th, 1972, Kaohsiung City, Taiwan
Citizen of Taiwan

Education

Drexel University	Finance	1997-2001	Ph.D.
Drexel University	Finance	1996-1997	MBA
National Cheng Kung University	Earth Sciences	1990-1994	BS

Honors

Teaching Assistant Excellence Award, 1999-2000, Drexel University

Teaching and Research Experience

08/2001 -- present	Assistant Professor, Department of Business Administration and Education, Emporia State University.
1999 -- 2000	Teaching Assistant, Department of Finance, Drexel University.
10/20 -- 11/05/1997	Instructor, Executive Finance Program for the Shanghai Port Authority, Drexel University.
1997 – 2001	Research Assistant, Department of Finance, Drexel University.
1996 – 1997	Graduate Assistant, Rocereto Computer Lab., Drexel University.
1994 – 1995	Research Assistant, Department of Earth Sciences, National Cheng Kung University.

Presentations at Professional Meetings

- Chen, Yi-Kai, Joseph Mason, and Eric Higgins. "Economies of Scale in the Banking Industry: The Effects of Loan Specialization," 2001 Southern Financial Association Annual Meeting, Destin, Florida.
- Chen, Yi-Kai, Joseph Mason, and Eric Higgins. "Does Bank Efficiency Change with the Business Cycle? The Relationship between Monetary Policy, Economic Growth, and Bank Condition," 2001 Financial Management Association International Annual Meeting, Toronto, Ontario.
- Chen, Yi-Kai, Joseph Mason, and Eric Higgins. "Do Agricultural Activities Matter to the Efficiency of U.S. Banks? Evidence from Pennsylvania, Florida, Illinois, Kansas, Texas, and California between 1988 and 1997," 2000 Financial Management Association International Annual Meeting, Seattle, Washington.
- Verzilli, Andrew G. and Yi-Kai Chen et. al. "Asian Crisis – The Economic Impact: An Interdisciplinary Approach," Pennsylvania Economic Association 1998 Conference, Allentown, Pennsylvania.

Service

06/2000 – 10/2000	Executive Board, Graduate Student Association (GSA), Drexel University
10/1999 -- 06/2000	President, Graduate Student Association (GSA), Drexel University
01/1999 -- 10/1999	Treasurer, Graduate Student Association (GSA), Drexel University